BTEC National Coursework.

Witness Documents

Witness Statement (Y1).

DICE

- Unit Title
  - ELECTRONICS
- Assignment Reference
  - 2291A
- Title
  - Electronic Dice.
- Task Ref / Description
  - Build/Construct and Test Logic Monitor.
  - Build/Construct and Test Logic Clock/Pulser.
  - Build on Breadboard 1 to 6 Logic Counter.
  - Build on Breadboard Display and Decoder.

Witness Statement (Y1).

AMPLIFIER

- Unit Title
  - ELECTRONICS
- Assignment Reference
  - 2291B
- Title
  - Amplifier.
- Task Ref / Description
  - Build/Construct Voltage Amplifier.
  - Build/Construct Power Amplifier.
  - Use of Multimeter.
  - Use of Signal Generator and Oscilloscope.

Witness Statement (Y1).

SIMULATION

- Unit Title
  - ELECTRONICS
- Assignment Reference
  - 2291D
- Title
  - Computer Based Electronics.
- Task Ref / Description
  - Simulate Voltage Amplifier.
  - Simulate 1-6 Counter for Dice.
  - TBA.
  - TBA.

Witness Statement.

Principles

- Unit Title
  - MICROELECTRONICS
- Assignment Reference
  - 2295A
- Title
  - Micro hardware architecture and principles.
- Task Ref / Description
  - TBA

Witness Statement (Y1).

Downloading

- Unit Title
  - MICROELECTRONICS
- Assignment Reference
  - 2295B
- Title
  - Micro software/firmware principles.
- Task Ref / Description
  - In and Out (INOUT).
  - Flash (FLASH).
  - Binary Count (BINCO UP/DOWN).
  - Knight Rider (NRIDER).
  - Checkerboard (CHECK)

Witness Statement.

Application

- Unit Title
  - MICROELECTRONICS
- Assignment Reference
  - 2295C
- Title
  - Planning, writing, running and testing software.
- Task Ref / Description
  - Produce and document code.
  - Produce efficient compact code.
  - Illustrate code (Selection, Iteration and Modularity).
  - Evaluate code (Report format).

Witness Statement.

Interface

- Unit Title
  - MICROELECTRONICS
- Assignment Reference
  - 2295D
- Title
  - Micro hardware interfacing and principles.
- Task Ref / Description
  - TBA

Witness Statement.

Interface

- Unit Title
  - Electronics Measurement and Test.
- Assignment Reference
  - 2299B1
- Title
  - Specifications and Test Procedures.
- Task Ref / Description
  - Regulated Power Supply Test Procedure.
  - Split Rail Converter Test Procedure.
  - Fixed Gain Amplifier Test Procedure.
  - Attenuator and Buffer Test Procedure.

Write ups and Submission Documents

Write up and Submission Documents.

- Structure of General/ Formal **Report** Submissions :-
  - Title of Submission
  - Introduction
    - What this report's content will identify.
  - Description containing :-
    - What I have done, why and how I did it.
    - What I expected and what happened.
  - Circuit and/or Diagrams (Photographs of constructions).
  - Results
    - in Tabular and/or graphical form(with annotated points of interest).
    - Calculation you may have used.
  - Conclusion / Comments
    - The implication and I have understood from my submission work.

Write up and Submission Documents.

- Structure of Laboratory **Report** Submissions :-
  - Experiment Title: Title and Date.
  - Objective: Briefly .. What you intend to do or achieve.
  - Equipment used: Record any serial numbers of used equipment.
  - Method: Consisting of :-
    - Circuit and/or Diagrams (Photographs of constructions etc.).
    - Description containing :-
      - What I have done, how I did it.
      - What I expected and what happened.
  - Results
    - in Tabular and/or graphical form(with annotated points of interest).
  - Conclusion / Comments
    - The implication and I have understood from my experimental work.

Write up and Submission Documents.

DICE

- Witness statements for :-
  - Build a 1 to 6 Logic Counter on Breadboard.
  - Build a Display and Decoder on Breadboard.
- Submissions required on Test Equipment
  - Testing the Pulser using a **Multimeter**.
    - Identify and measure voltages (Table of results)
  - Testing the Clock using an **Oscilloscope**.
    - Draw precise grid, show waveforms of clock output, record scope settings, Mark key points of interest.
  - Testing the counter/s using your **Logic probe**.
    - show waveforms of outputs and time relationships.
    - show truth table of expected/actual outputs.

Write up and Submission Documents.

AMPLIFIER

- Witness statements for :-
  - Build a Voltage Amplifier on Breadboard.
  - Build a Power Amplifier on Breadboard.
- Submissions required on Test Equipment
  - Testing the Amplifier using a **Multimeter**.
    - Identify and measure voltages (produce table of results)
  - Testing the Amplifier using both an **Oscilloscope** and a **Signal Generator**.
    - Sketch using a precise grid, waveforms of signals, include (inputs , outputs and time) relationships, record scope settings, mark key points of interest on diagrams.

Write up and Submission Documents.

SIMULATION

- Witness statements for :-
  - Demonstration Simulation of Voltage Amplifier.
  - Demonstration Simulation of 1-6 Counter for Dice.
- Hardcopy Submissions required
  - Screen shots of Simulations and Calculations.
    - Identify and measure voltages etc... tables of results.
    - Record Digital waveforms/levels showing state table.
    - Plot Voltage and Frequency graph of the Amplifier.
    - As above when gain is changed * 3.
    - Mini Report relating Simulated and Practical results for voltage amplifier.

Write up and Submission Documents.

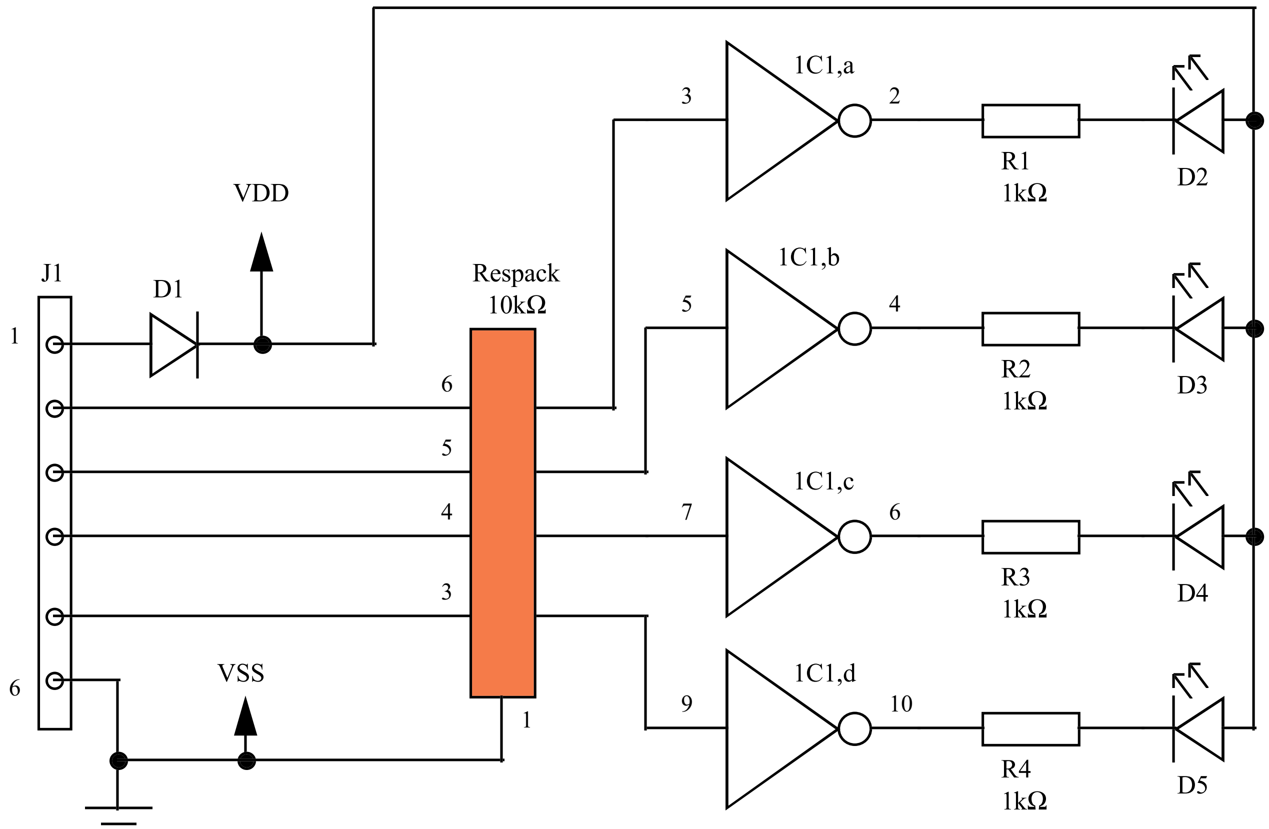
DOWNLOAD

- Witness statements for :-
  - Demonstration of Download of all programmes.
- Hardcopy Submissions required
  - Source code fully commented.
    - Fully commented source codes that you have downloaded.
    - Flowcharts of programme operation.
    - Structured walk through of programme code (fully annotated (show principle register and memory locations and how they change)).

Build and Test LOGIC Probe

Logic Probe Board.

IC1 = CMOS 4049

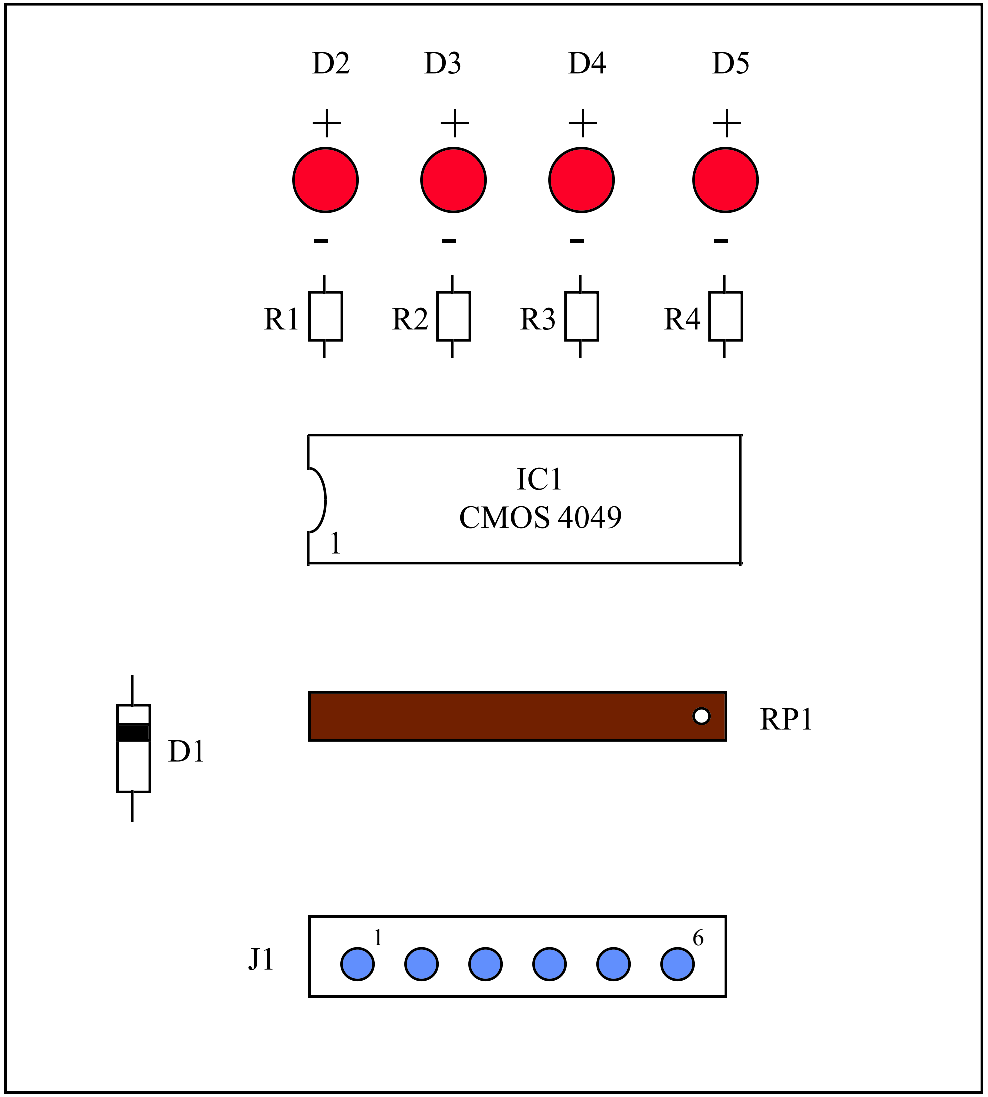


Circuit of Logic Probe Board

IC1,8 = VSS

IC1,1 = VDD

Logic Probe Board.



Layout of
Probe Board

Testing Logic Probe.

- Check all solder connections (Shiny, Concave, No lumps bumps holes)
- Have all links and Components been made/located in the correct place the right way round.
- Verify that all tracks connect to the correct place and no additional short circuits added.
- Ensure IC1 is **NOT** yet fitted.

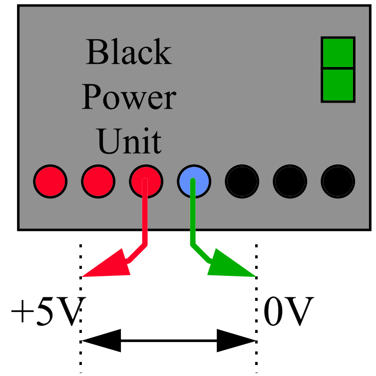
Testing Logic Probe.

- Track checking Verify
- **S/C checks**
- J1,6 → IC1,8
- IC1,1 → D1,- → D2,+ → D3,+ → D4,+ → D5,+
- IC1,3 → J1,2
- IC1,5 → J1,3
- IC1,7 → J1,4
- IC1,9 → J1,5
- **O/C Checks**
- D1,+ → D1,- (also check D2,D3,D4 and D5 same way)
- IC1,1 → IC1,8

Testing Logic Probe.

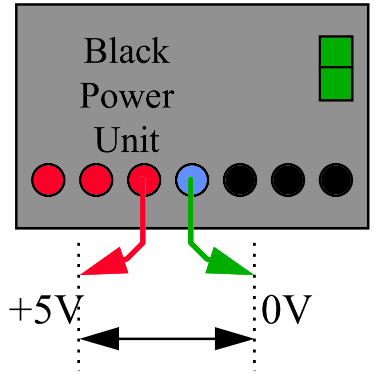
- Resistance Checks (No Power applied).
- **Resistance Checks**
- Verify J1,2 $\rightarrow$ J1,6 = 10kΩ
- Verify J1,3 $\rightarrow$ J1,6 = 10kΩ
- Verify J1,4 $\rightarrow$ J1,6 = 10kΩ
- Verify J1,5 $\rightarrow$ J1,6 = 10kΩ

Testing Logic Probe.



- Apply power to board if previous tests OK.
  - Pin J1,1 = +5V , Pin J1,6 = 0V
- **S/C checks**
- Short J1,6 → IC1,2 (LED D2 should Light)
- Short J1,6 →IC1,4 (LED D3 should Light)
- Short J1,6 →IC1,6 (LED D4 should Light)
- Short J1,6 →IC1,10 (LED D5 should Light)
- Remove Power from board
- If all previous tests OK insert IC1 into board.

Testing Logic Probe.

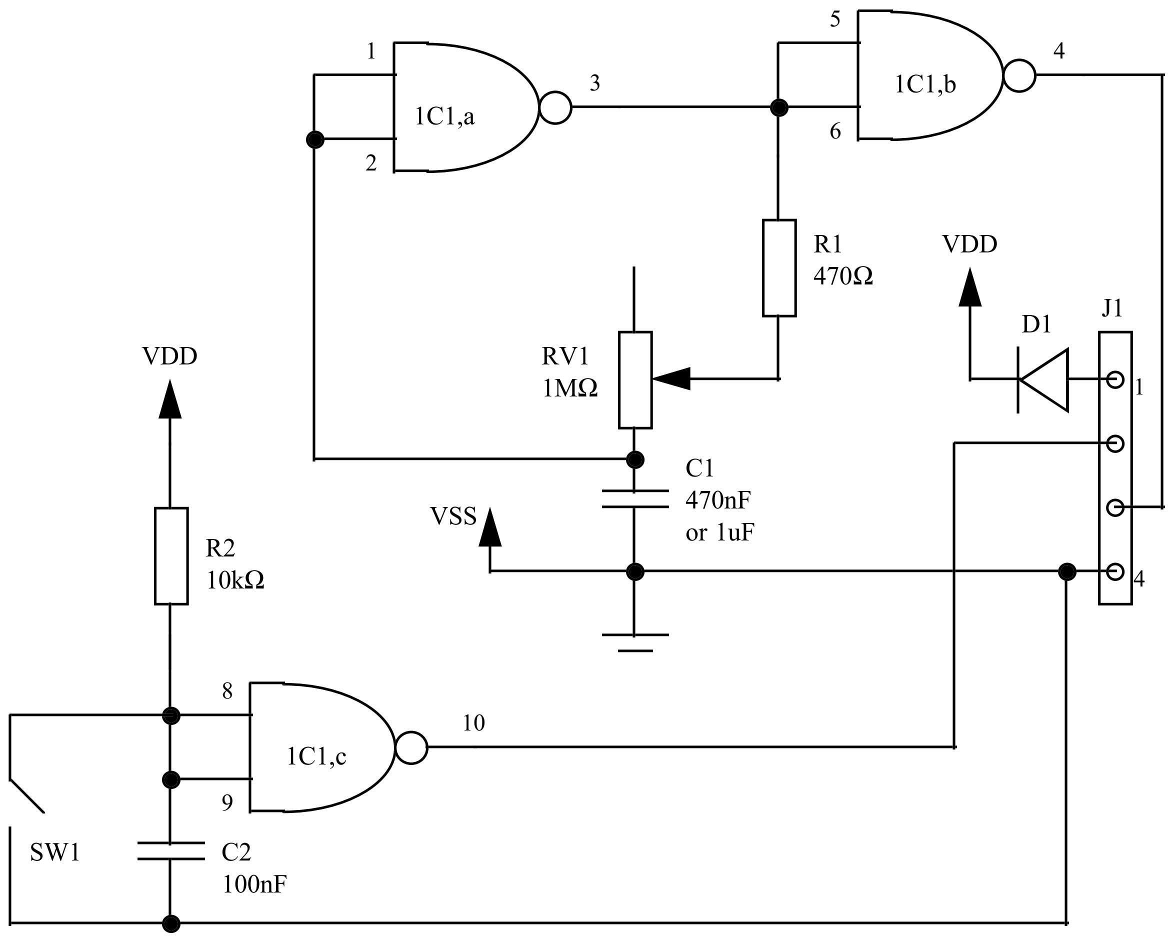


- Verify full functionality.
- Apply power to board +5V.
  - Pin J1,1 = +5V , Pin J1,6 = 0V
- All LEDs should be OFF.
- **S/C checks**
- Short J1,1 → J1,2 (LED D2 should Light)
- Short J1,1 → J1,3 (LED D3 should Light)
- Short J1,1 → J1,4 (LED D4 should Light)
- Short J1,1 → J1,5 (LED D5 should Light)
- If all LEDs light with above tests the board is fully functional.

Build and Test a Debounced Switch and Clock Board

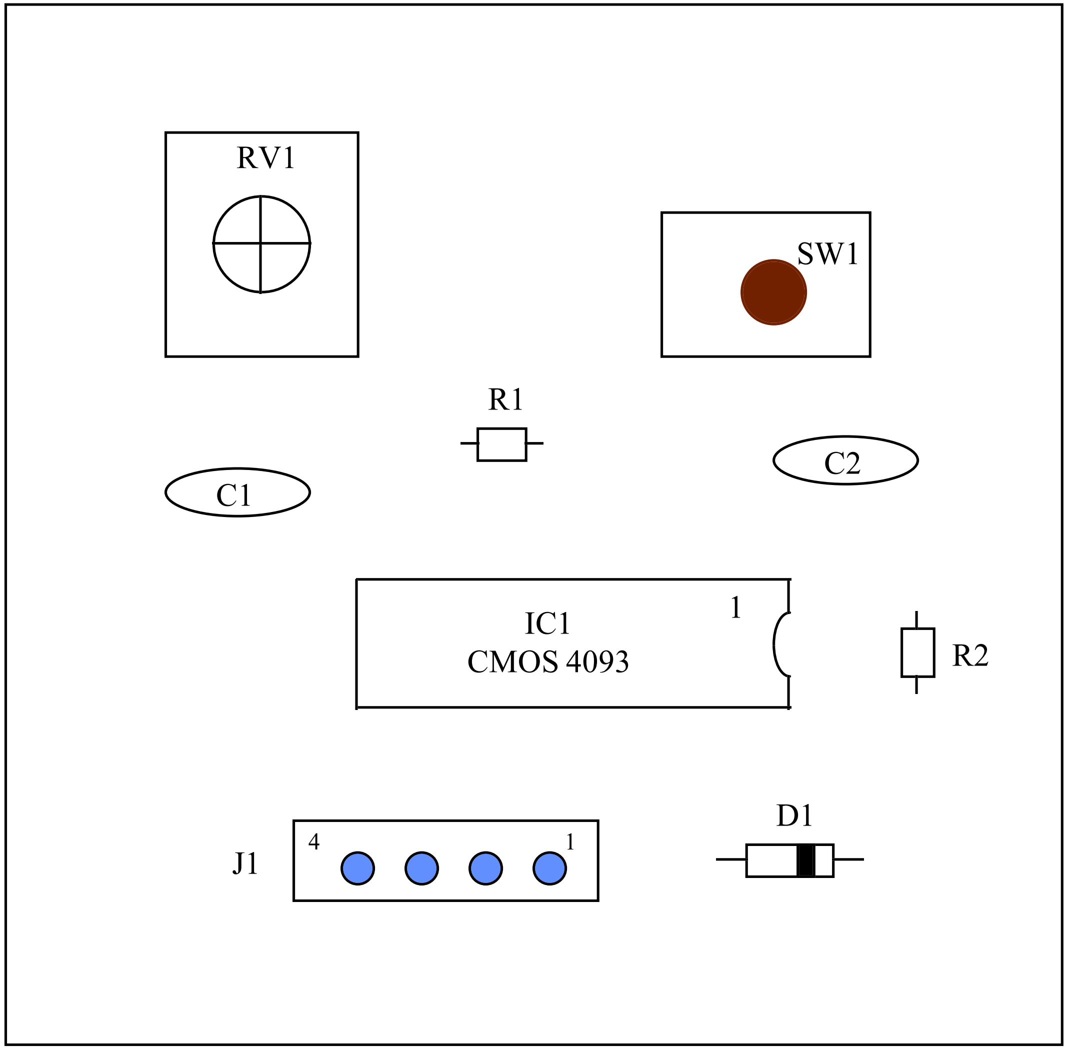
Level and Clock Board.

IC1 = CMOS 4093



Circuit of
Level and Clock
Board

Level and Clock Board.



Layout of
Level and Clock
Board

Level and Clock Board.

- Track checking Verify
- **S/C checks**
- J1,4 → IC1,7
- IC1,1 → IC1,2
- IC1,5 → IC1,6
- IC1,8 → IC1,9
- IC1,4 → J1,3
- IC1,10 → J1,2
- **O/C Checks**
- IC1,7 → IC1,14

Level and Clock Board.

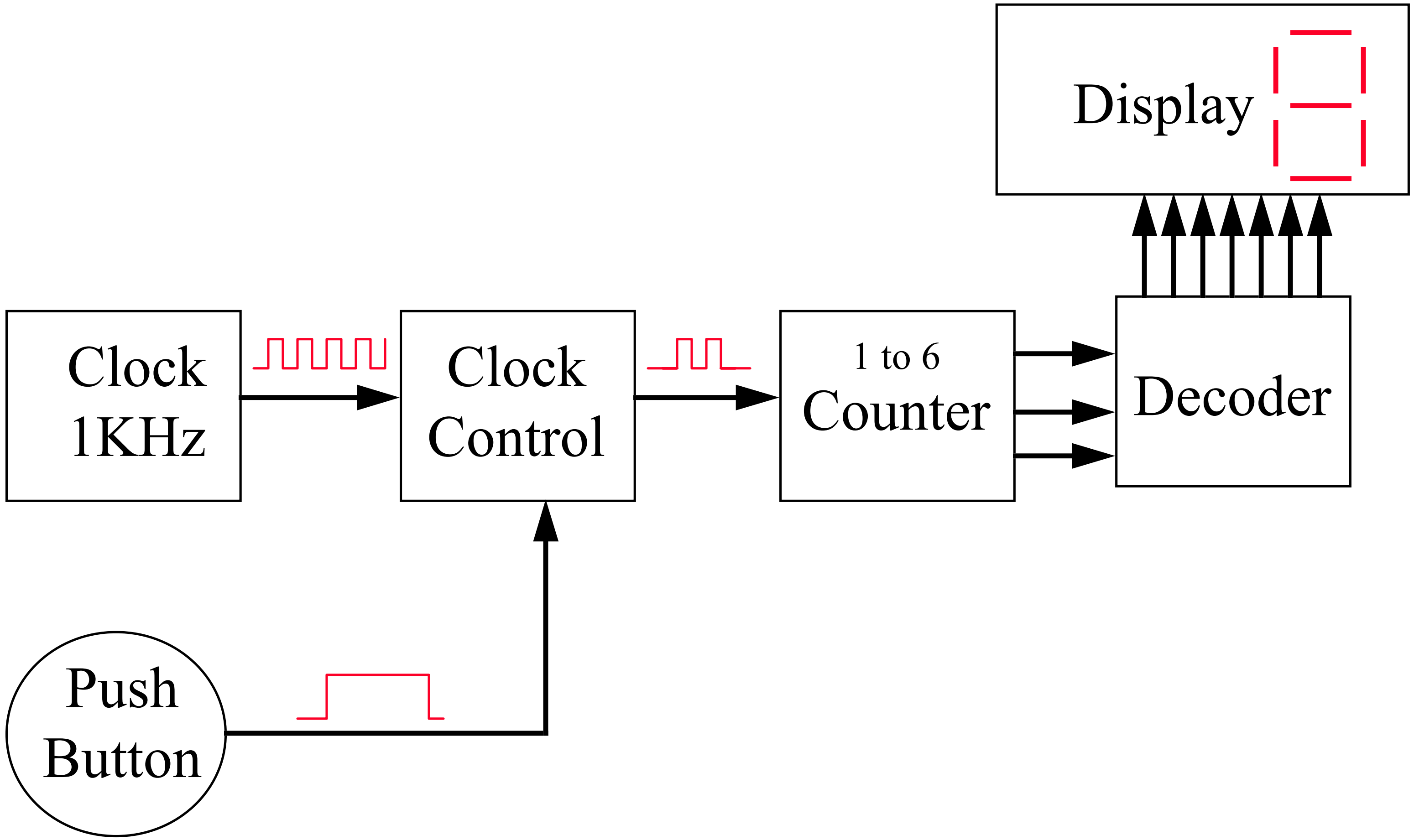
- Resistance Checks (No Power applied).
- **Resistance Checks**
- Verify J1,4 → IC1,8 = S/C when Switch Pressed
- Verify IC1,14 → IC1,8 = 10kΩ
- If all previous tests OK insert IC1 into board.

Level and Clock Board.

- Functional Checks (Power applied).
- **Power Applied Checks**
- Connect +5V to J1,1 and Ground / 0V to J1,4
- Connect using your Logic probe : J1,2 to one channel and J1,3 to another channel. (Remember to Power your Probe).
- Press Switch and the selected channel should come on.
- Rotate RV1 until other channel flashes about once a second. Other extreme end RV1, LED appears always on
- Check Maximum frequency and waveshape of clock signal [Use Scope] (Sketch Waveforms) {Calculate Frequency}
- If LEDs light correctly with above tests and waveforms are square then the Level and Clock board is fully functional.

Digital Dice Assignment

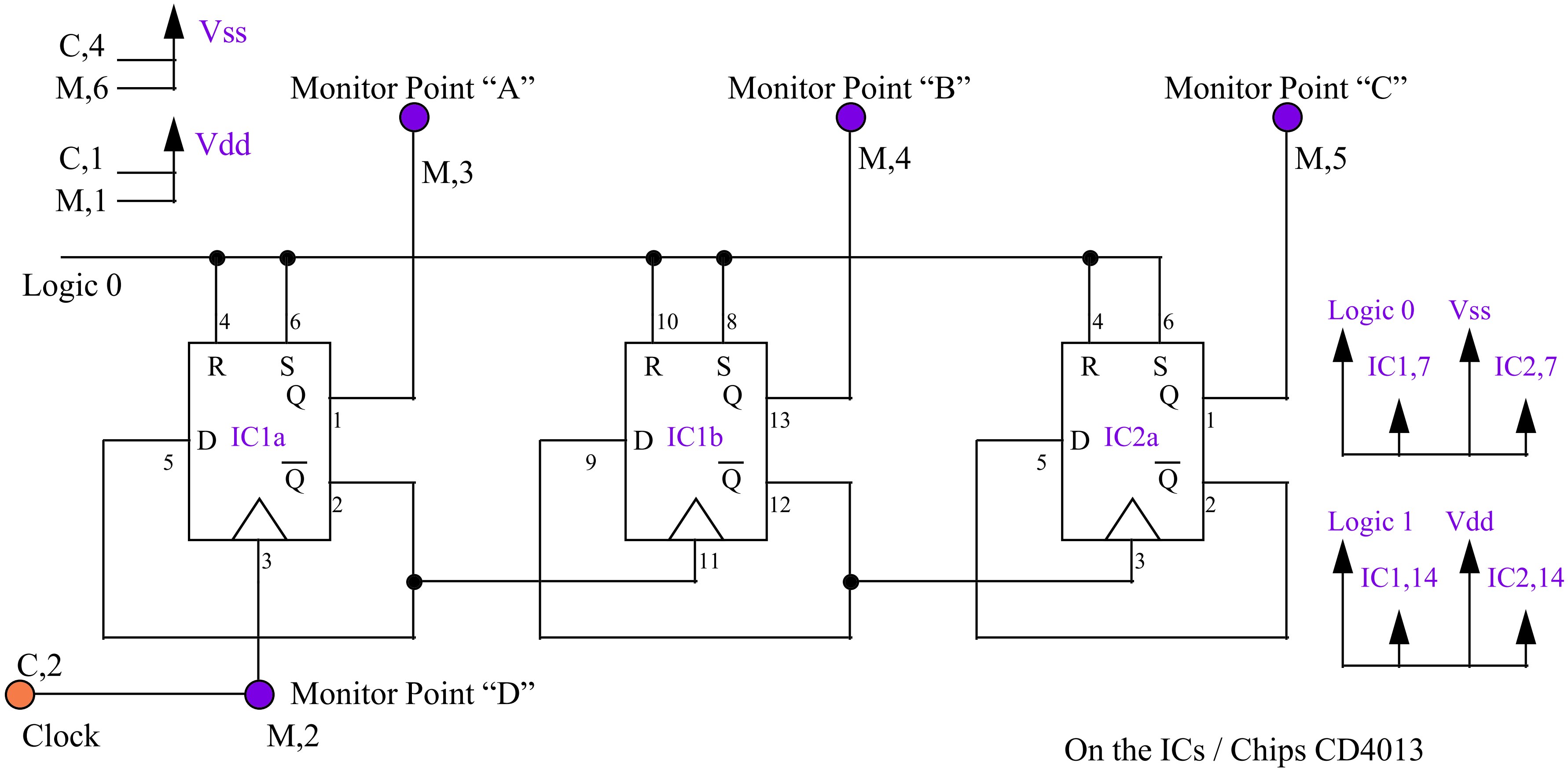
Digital Dice Block Diagram.



Build and Test a 0 to 7 Counter

Digital Dice Counter Circuit.

Monitor and Record what happens at the monitor points.



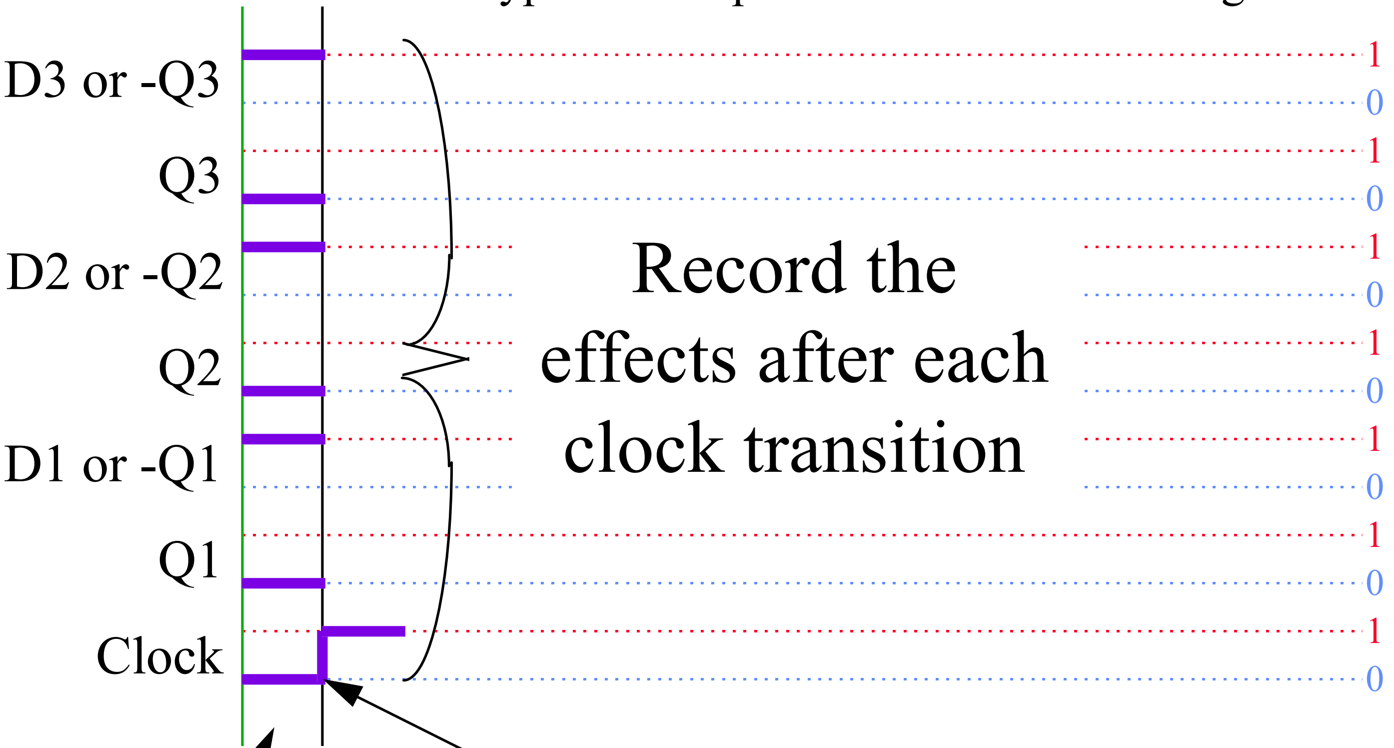
Basic Counter Circuit

On the ICs / Chips CD4013
Connect VSS to Ground/0V
Connect VDD to +5V

Digital Dice Counter Circuit.

Record/Indicate what happens at the monitor points.

Typical example of waveform recording.



Initially define Start Conditions here.

First Clock transition Condition here.
Press Switch to give a logic level one and release switch to give a logic level zero.

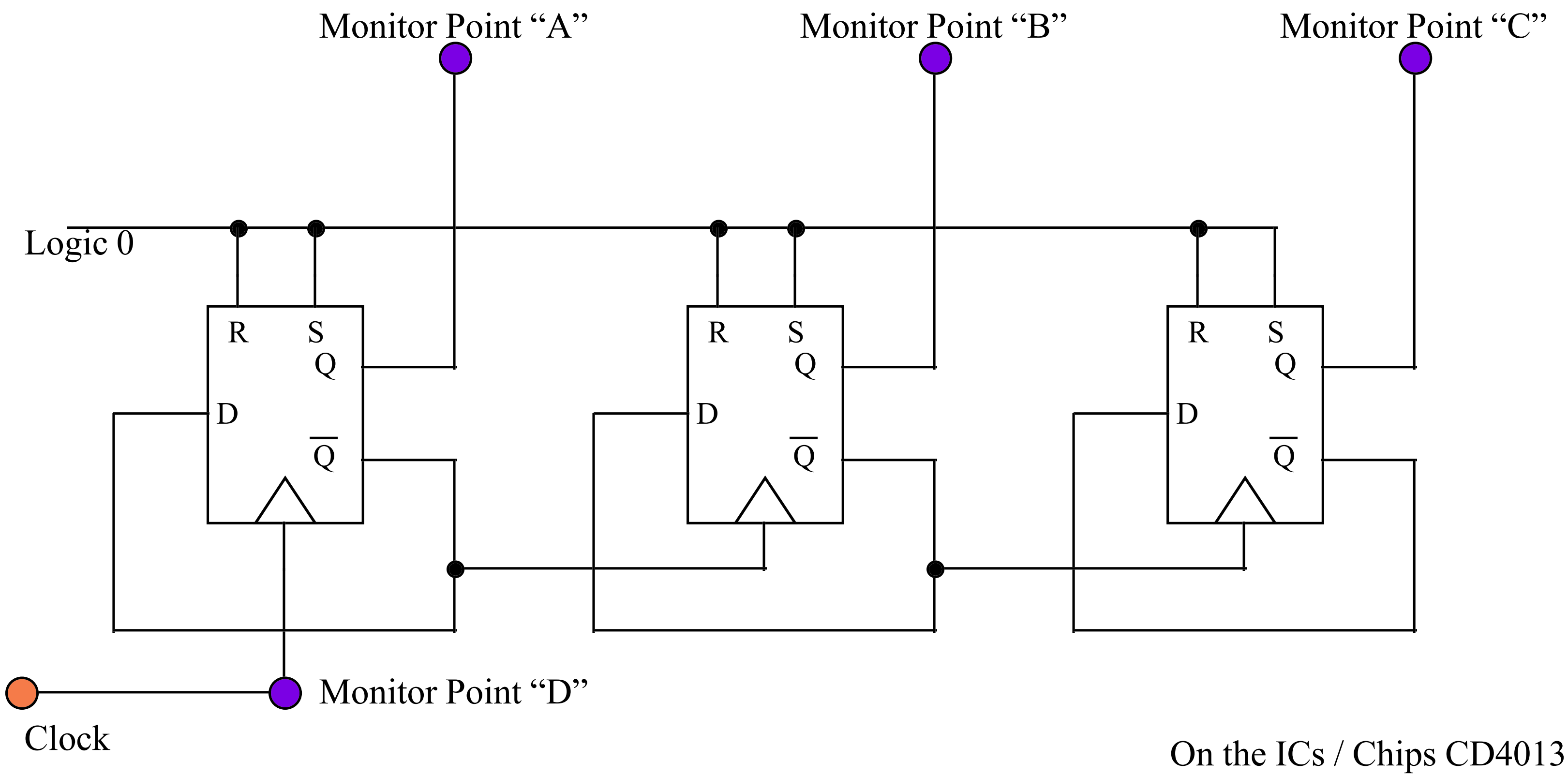
Formal Method to Create Bread Board Layouts

General Construction Concepts.

- Draw circuit diagram.
- Allocate names to all devices.
- Use Data sheets to identify pins of devices.
- Build a Resource list.
- Use Circuit Diagram to build NET List.
- Use NET list to wire up Breadboard.

Process complete

Digital Dice Counter Circuit.



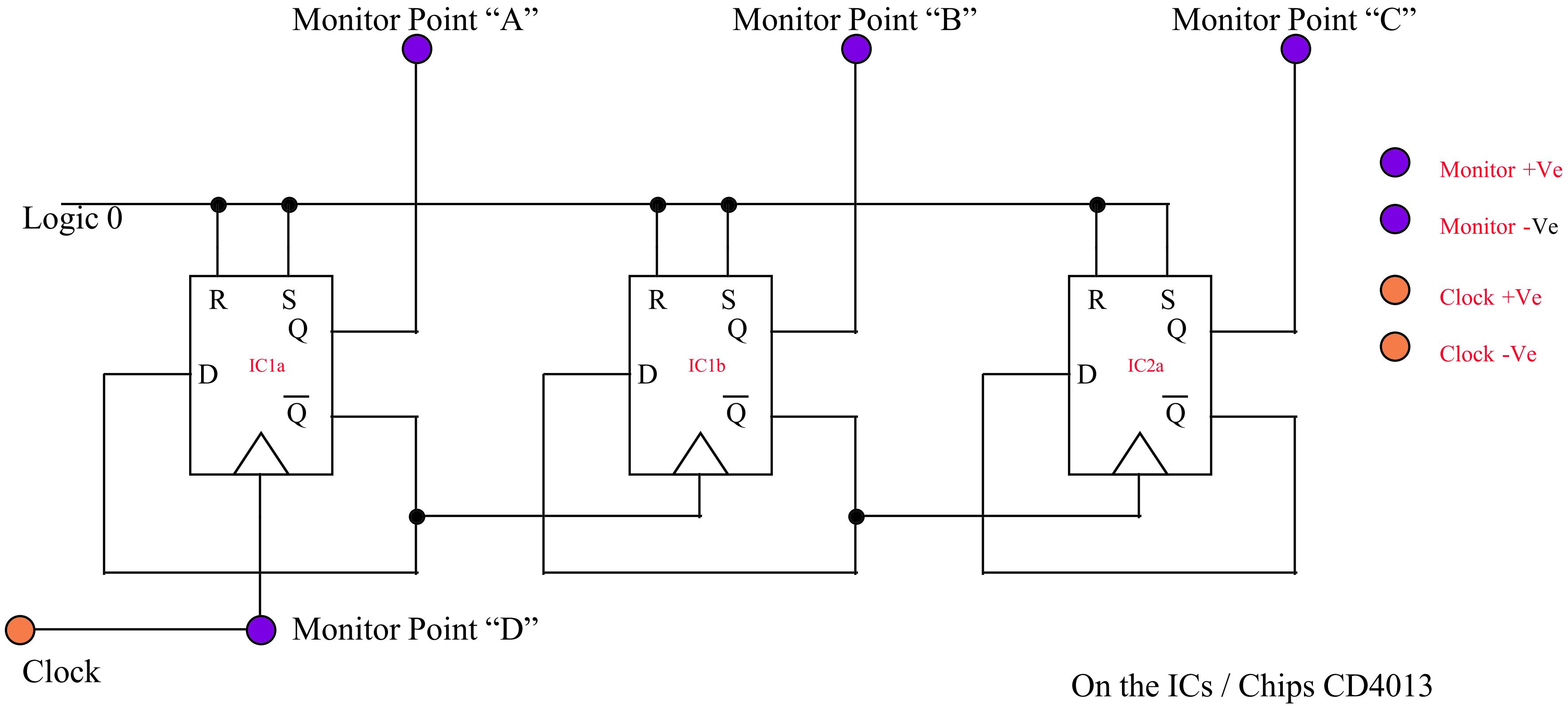
Basic Counter Circuit

On the ICs / Chips CD4013
Connect VSS to Ground/0V Logic 0
Connect VDD to +5V Logic 1

General Construction Concepts.

- Draw circuit diagram.
- Allocate Names to all devices.
- Use Data sheets to identify pins of devices.
- Build a Resource list.
- Use Circuit Diagram to build NET List.
- Use NET list to wire up Breadboard.

Digital Dice Counter Circuit.



Basic Counter Circuit

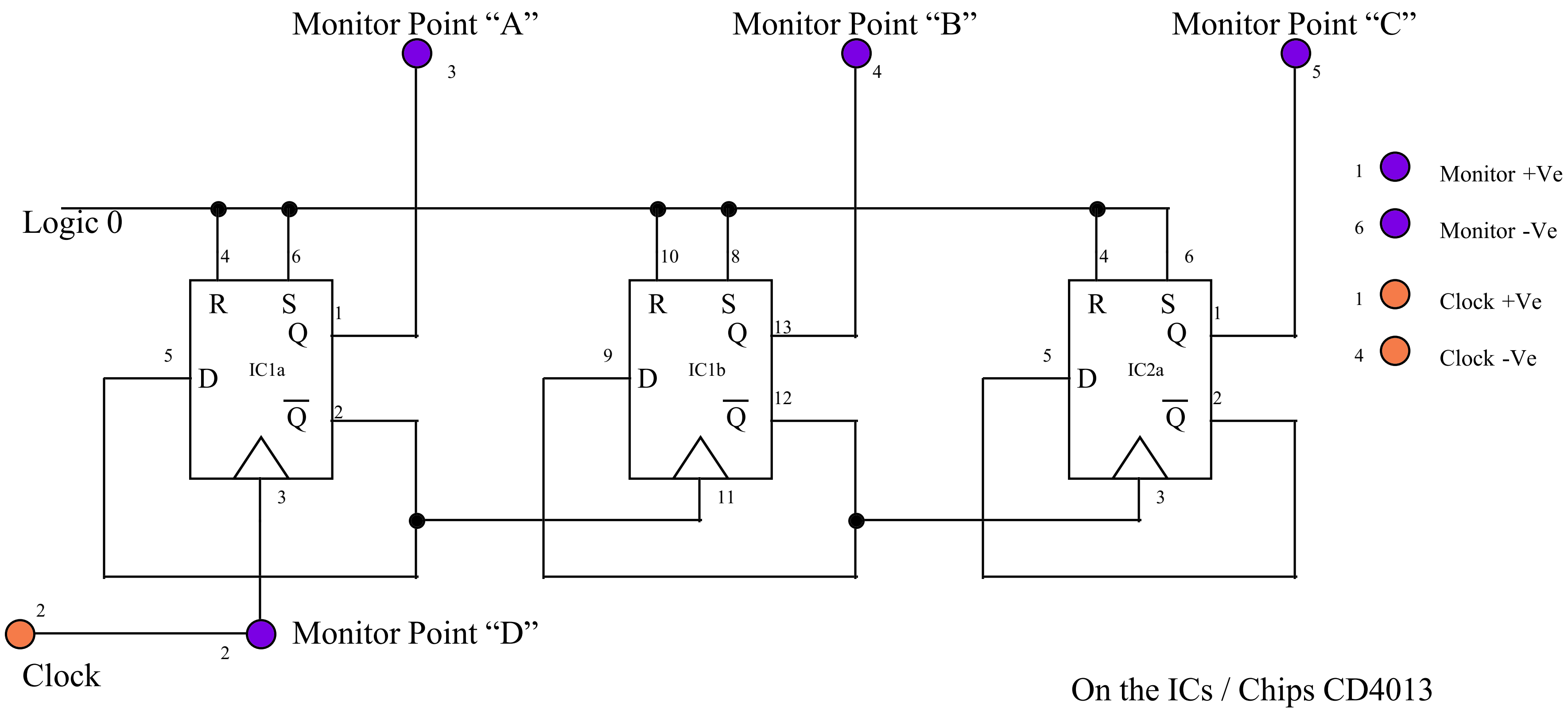
On the ICs / Chips CD4013
Connect VSS to Ground/0V Logic 0
Connect VDD to +5V Logic 1

General Construction Concepts.

- Draw circuit diagram.
- Allocate Names to all devices.
- Use Data sheets to identify pins of devices.
- Build a Resource list.
- Use Circuit Diagram to build NET List.
- Use NET list to wire up Breadboard.

Digital Dice Counter Circuit.

Monitor and Record what happens at the monitor points.



Basic Counter Circuit

On the ICs / Chips CD4013

7 7 Connect VSS to Ground/0V Logic 0

14 14 Connect VDD to +5V Logic 1

General Construction Concepts.

- Draw circuit diagram.
- Allocate Names to all devices.
- Use Data sheets to identify pins of devices.
- Build a Resource list.
- Use Circuit Diagram to build NET List.
- Use NET list to wire up Breadboard.

Resource List.

- Name ID Pins → →
- Count 1,2 IC1 1 2 3 4 5
  6 7 8 9 10 11 12 13 14
- Count 3 IC2 1 2 3 4 5 6
  7 14
- Monitor M 1 2 3 4 5 6
- Clock C 1 2 4
- Power + +5V 1
- Power/Ground 0V 1

General Construction Concepts.

- Draw circuit diagram.
- Allocated names to all devices.
- Use Data sheets to identify pin of devices.
- Build a Resource list.
- Use Circuit Diagram to build NET List.
- Use NET list to wire up Breadboard.

NET List.

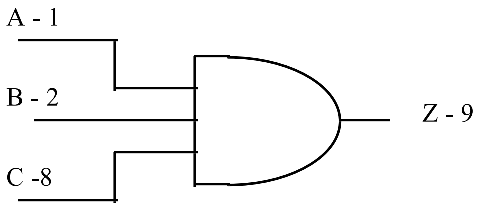
Name	ID	Pins and Connections
Power +V	+5V	+5V,1 → IC1,14 → IC2,14 → C,1 → M,1
Ground/Logic 0	0V	0V,1 → IC1,7 → IC2,7 → M,6 → C,4 → IC1,4 → IC1,6 → IC1,10 → IC1,8 → IC2,4 → IC2,6
Clock	CLK	C,2 → IC1,3 → M,2
Net	#1	IC1,5 → IC1,2 → IC1,11
Net	#2	IC1,9 → IC1,12 → IC2,3
Net	#3	IC1,1 → M,3
Net	#4	IC1,13 → M,4
Net	#5	IC2,1 → M5
Net	#6	IC2,2 → IC2,5

General Construction Concepts.

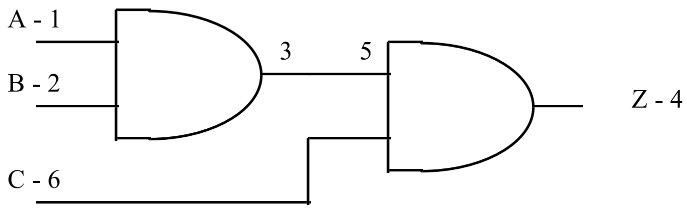
- Draw circuit diagram.
- Allocated names to all devices.
- Use Data sheets to identify pin of devices.
- Build a Resource list.
- Use Circuit Diagram to build NET List.
- Use NET list to wire up Breadboard.

Circuit Notes

Circuit Notes.



CD4073



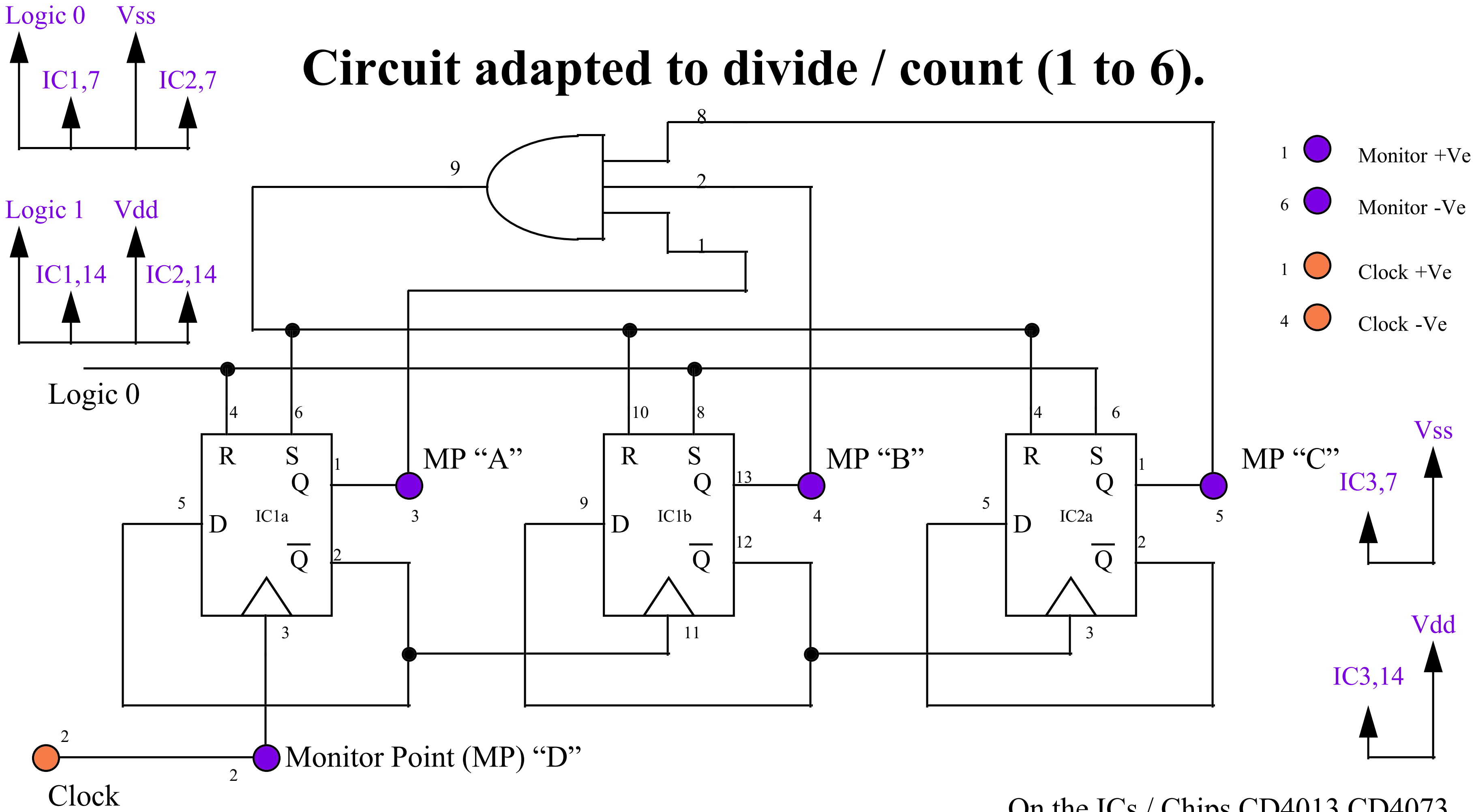
CD4081

Converting Two 2 Input AND gates
into a 3 Input AND Gate

Build and Test a 1 to 6 Counter

Digital Dice Counter Circuit.

Circuit adapted to divide / count (1 to 6).



Modified Counter Circuit

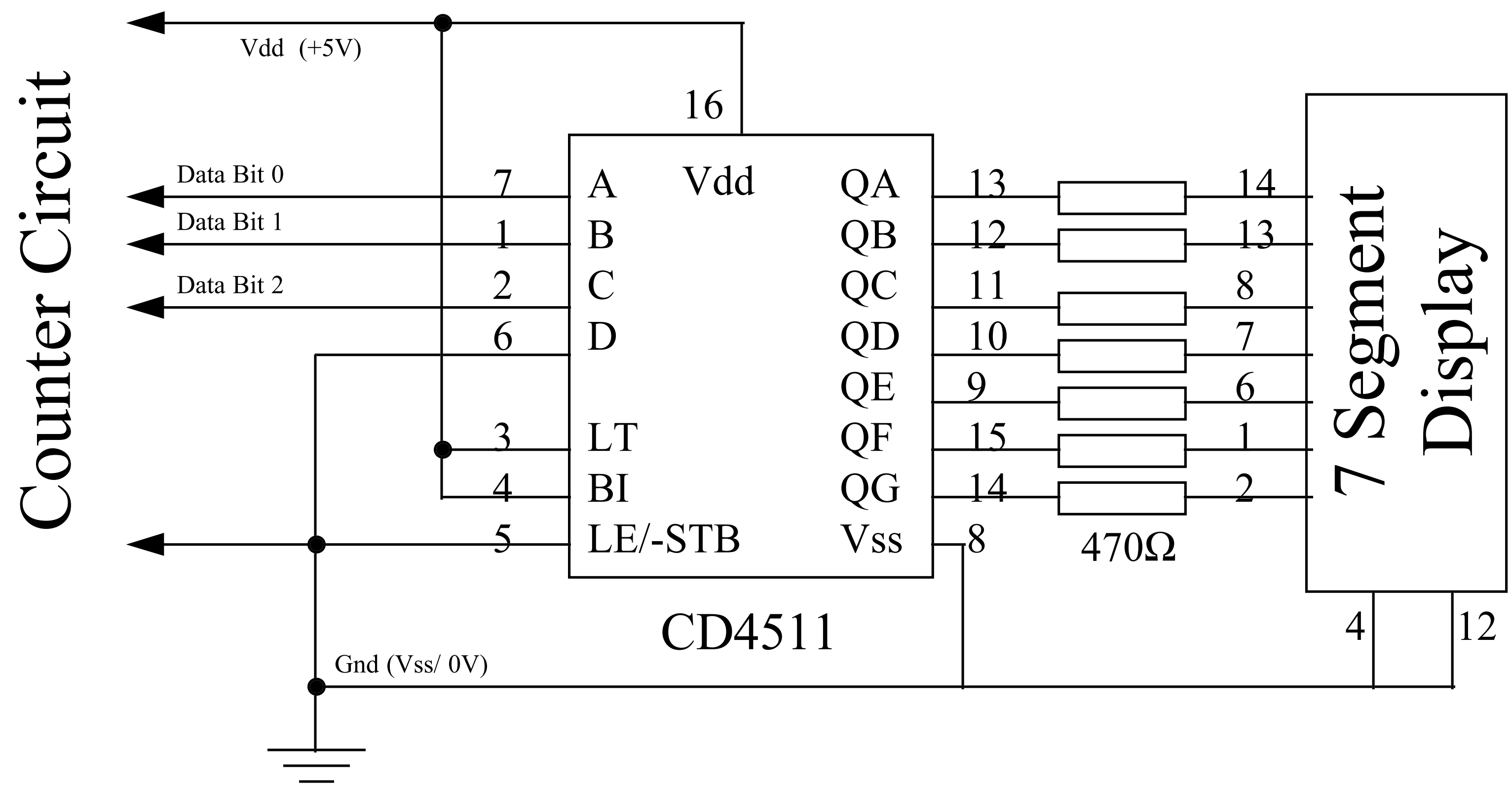
On the ICs / Chips CD4013 CD4073
Connect VSS to Ground/0V Logic 0
Connect VDD to +5V Logic 1

Circuit Notes.

- 1 to 6 Counter Board
  - Connection on U1:A,Q will go to your Logic Monitor pin M3.
  - Connection on U1:B,Q will go to your Logic Monitor pin M4.
  - Connection on U2:A,Q will go to your Logic Monitor pin M5.
  - Note U3:A may be constructed from 2 separate AND gates.
  - VDD = +5V and VSS = 0V

<u>Build and describe Operation of a Display / Decoder</u>

Display / Decoder.

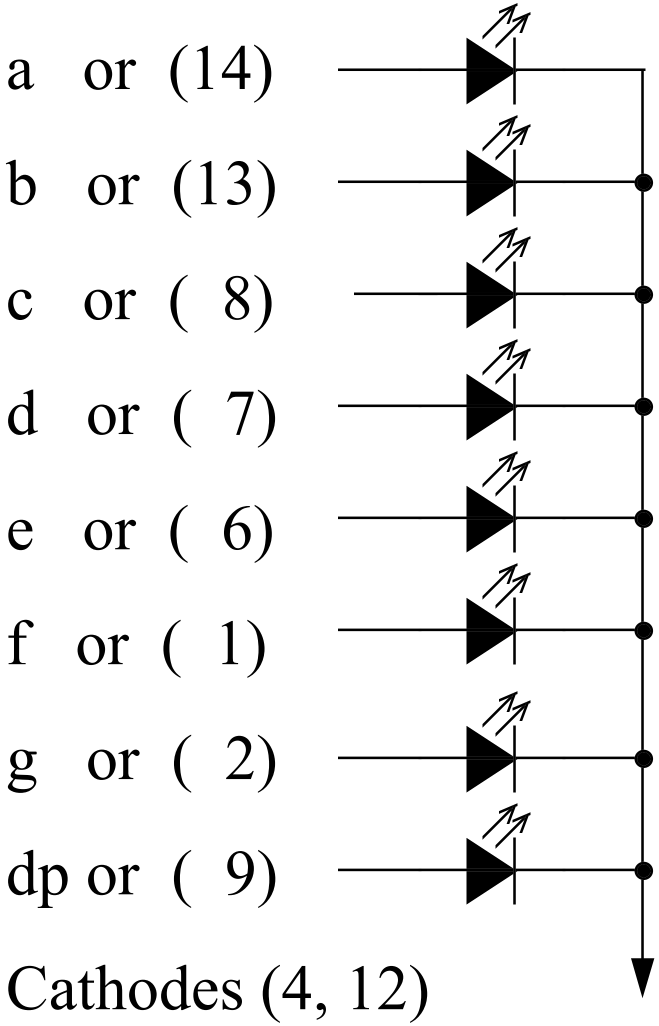


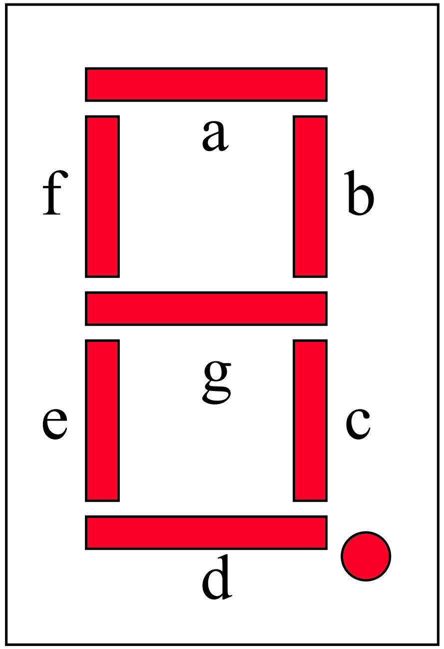
Circuit diagram for the Decoder - Display

Circuit Notes.

- Decoder / Display Board
  - Data Bit 0 will link to Q1 or QA on your counter.
  - Data Bit 1 will link to Q2 or QB on your counter.
  - Data Bit 2 will link to Q3 or QC on your counter.
  - U1,Pin 5 (LE/-STB) connects to Ground Vss.
  - U1,Pin 3 (LT) and U1,Pin 4 (BI) connect to Vdd.
  - Vdd = +5V and Vss = 0V

Display / Decoder.





N/c Pins are (3,5,10 and 11)

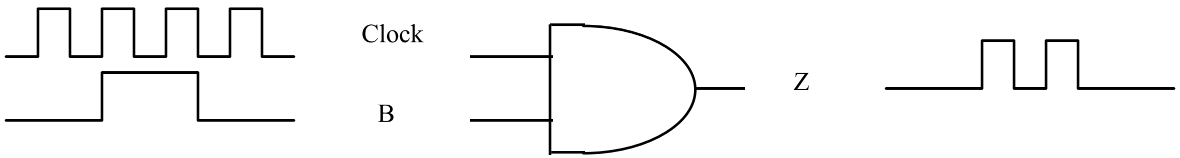
(The Common Cathode) Seven Segment Display.

Build and describe Operation of a Roll Dice Circuit

Circuit Notes.

Theory

AND Gate



A	B	Z
0	0	0
1	0	0
0	1	0
1	1	1

A	B	Z
Clock	0	0
Clock	1	Clock

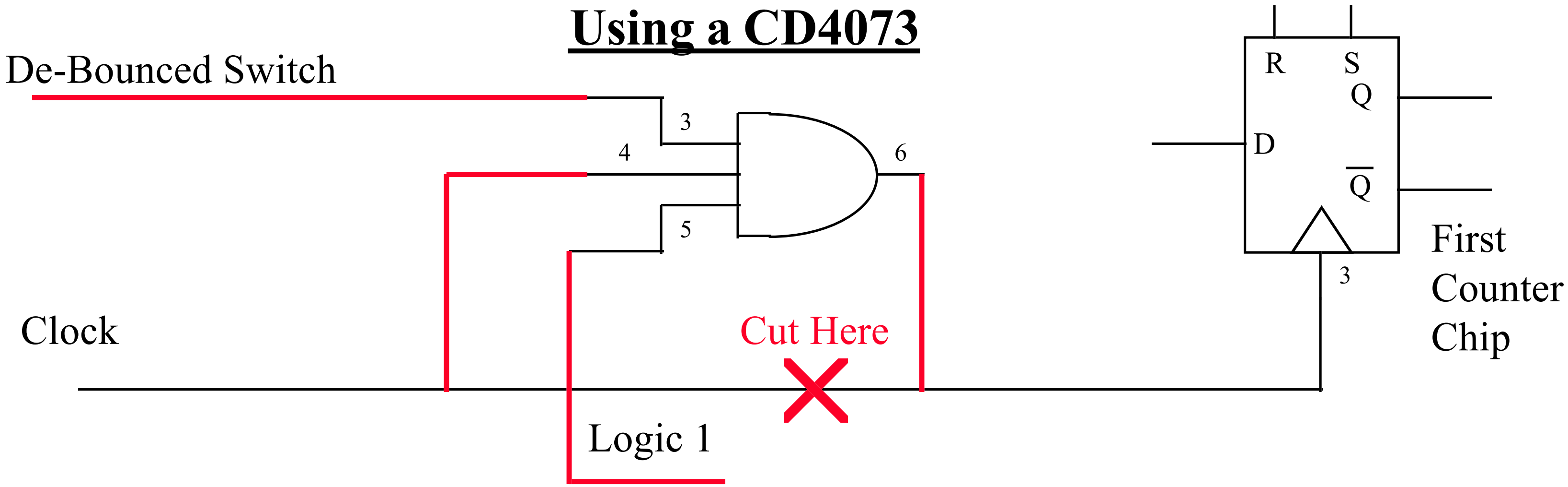
0	1	0
1	1	1

Control

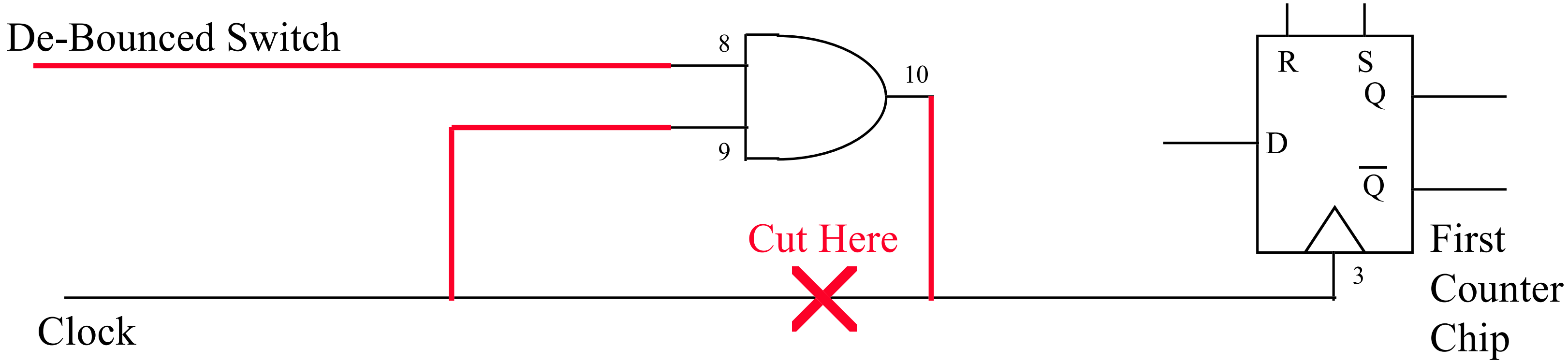
Circuit to Gate or control the flow of pulses.

Circuit Notes.

Using a CD4073



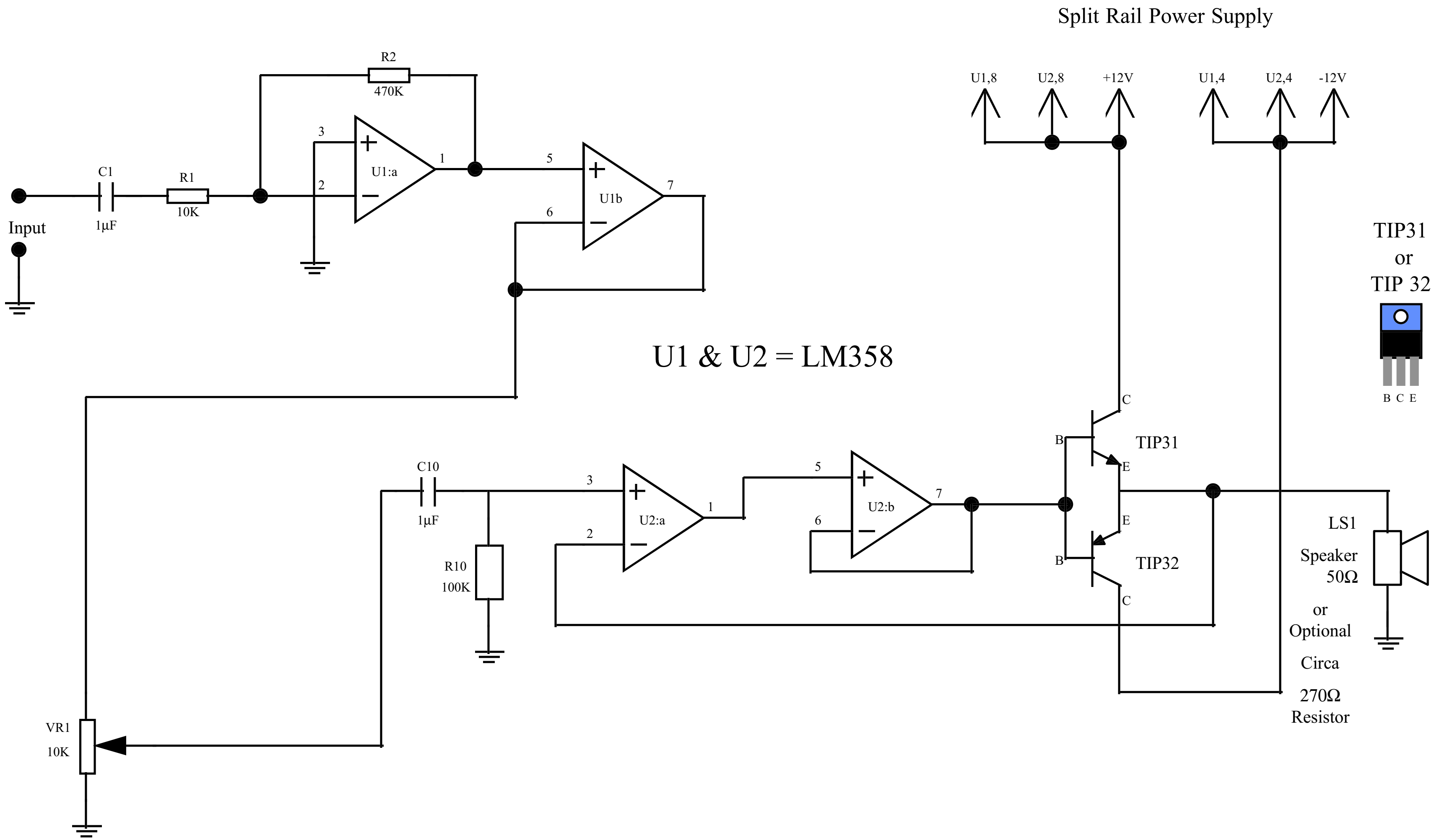
Using a CD4081



Adding the Roll Dice function.

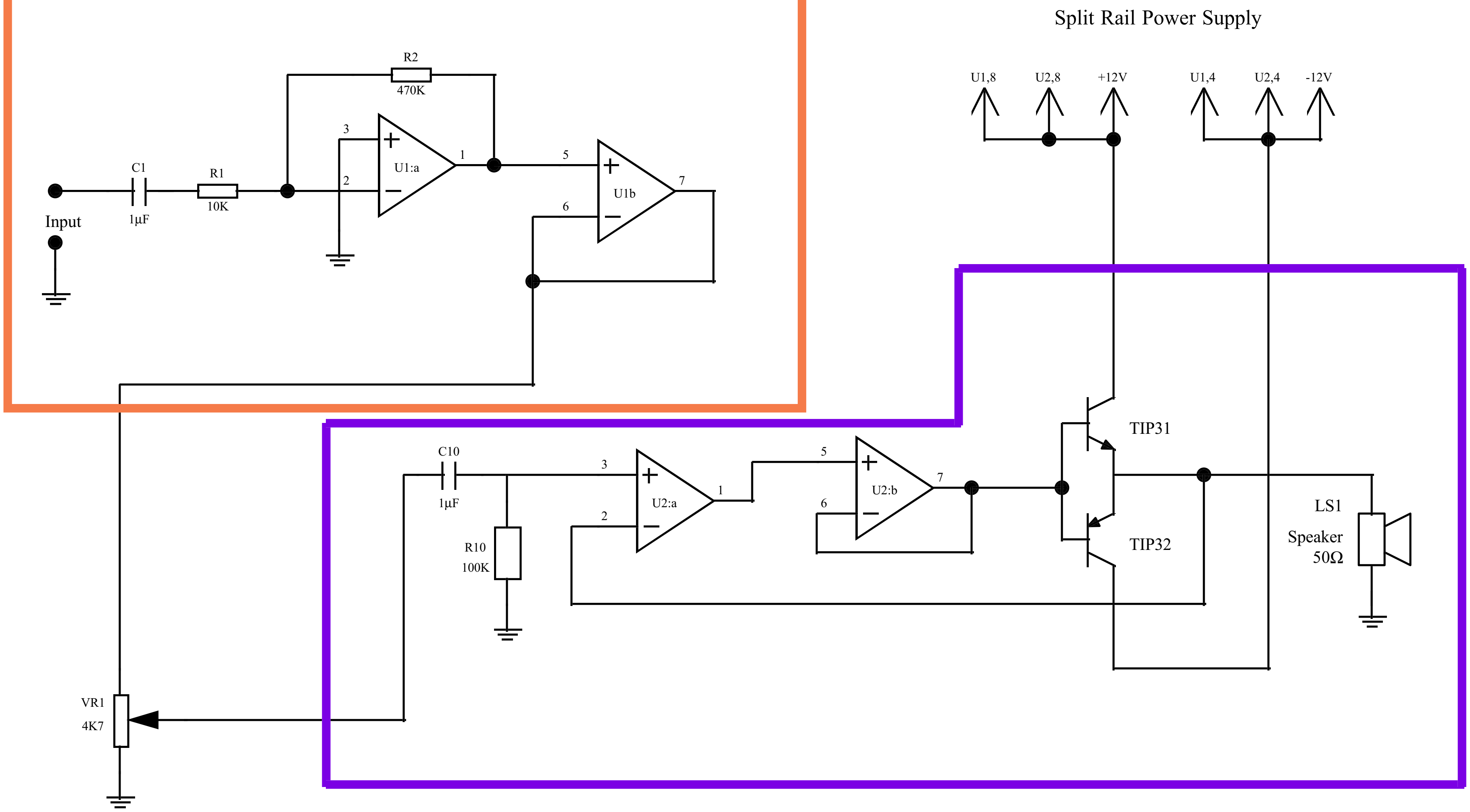
Amplifier

The Amplifier.



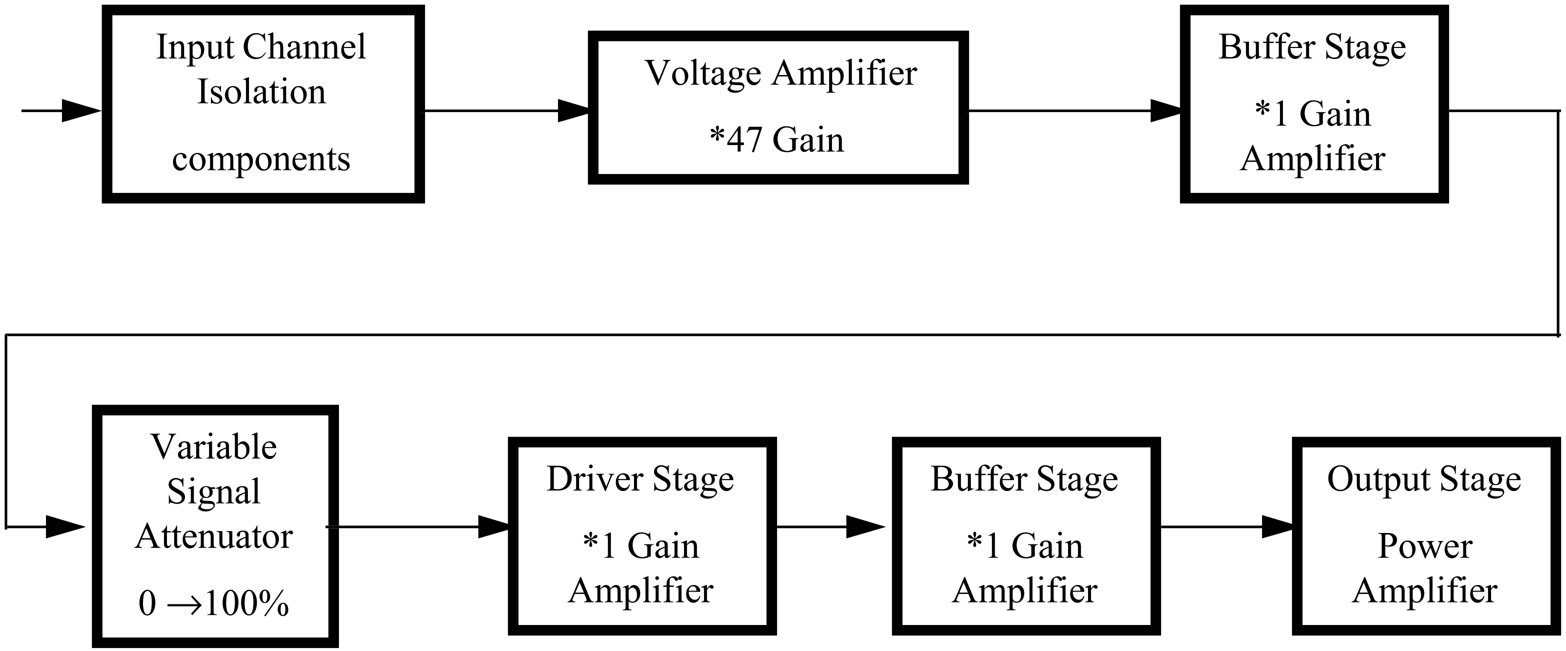
The Amplifier (Final Design).

The Amplifier.



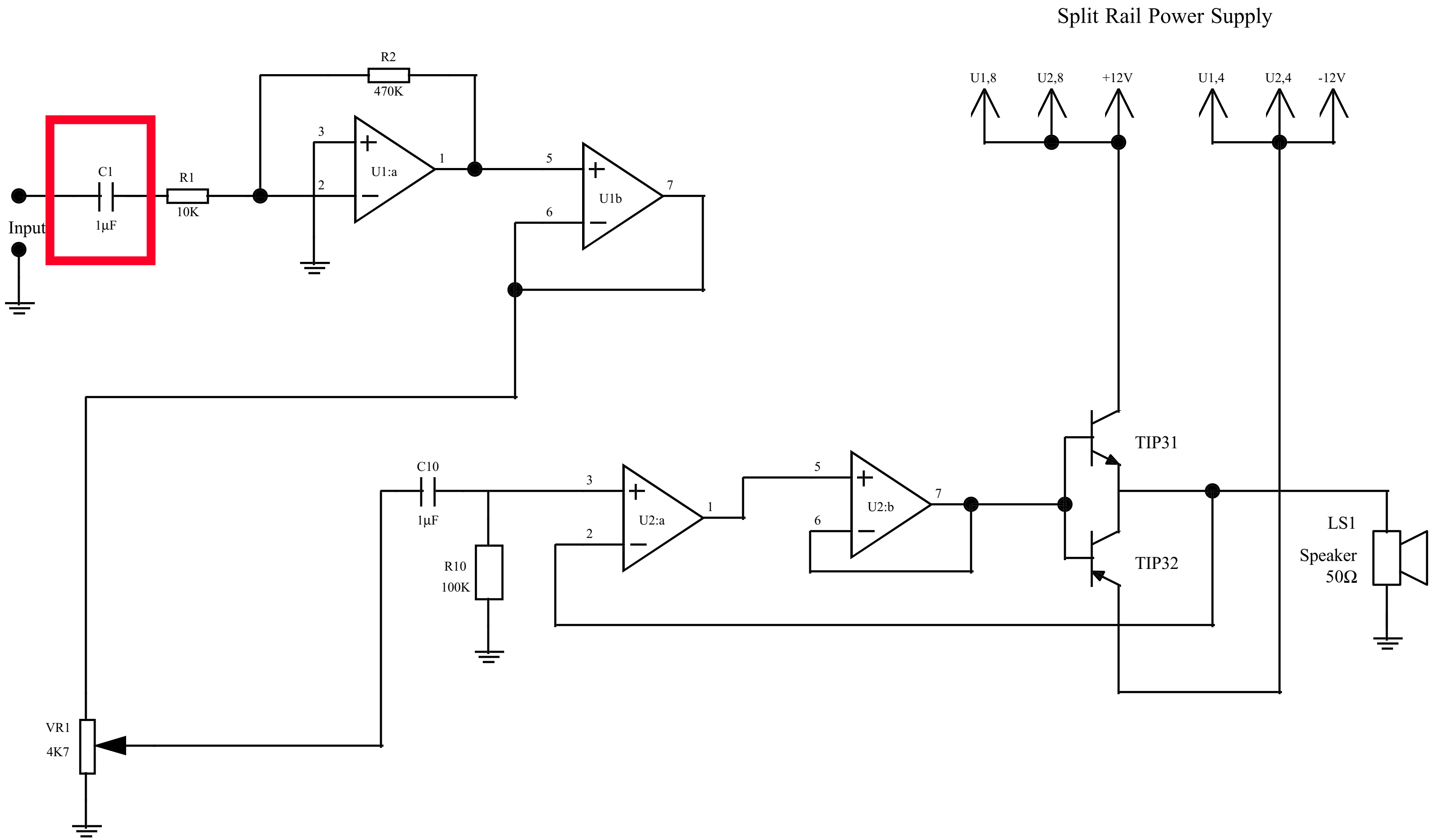
The Amplifier (Module Design).

Amplifier Theory.



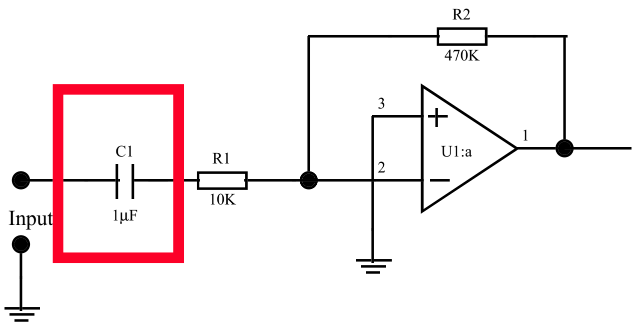
Block Diagram.

The Amplifier.



Capacitor coupling (DC Block).

The Amplifier.



The Coupling Capacitor reactance

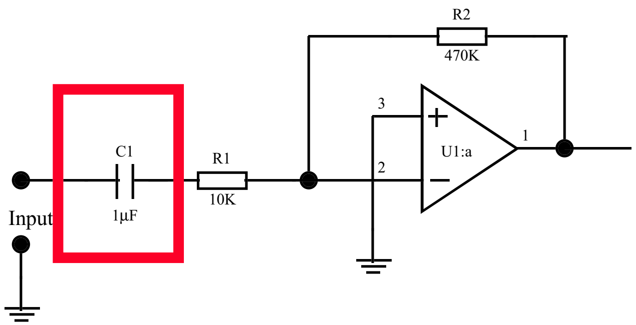
$$Xc = \frac{1}{2\pi FC}$$

F = 100Hz and C = 1μF

$$Xc = \frac{1}{2 * \pi * 100 * 10^{-6}} = \frac{10^6}{2 * \pi * 100} = ?$$

Capacitor coupling (DC Block).

The Amplifier.



The Coupling Capacitor reactance

$$Xc = \frac{1}{2\pi FC}$$

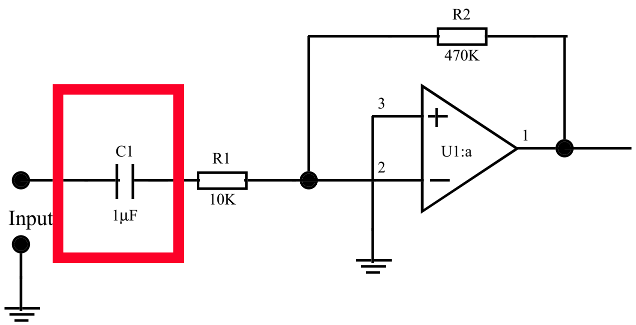
F = 100Hz and C = 1µF

$$Xc = \frac{1}{2 * \pi * 100 * 10^{-6}} = \frac{10^{6}}{2 * \pi * 100} = 1591\Omega$$

So what if F = 10KHz.

Capacitor coupling (DC Block).

The Amplifier.



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$$Xc = \frac{1}{2\pi FC}$$

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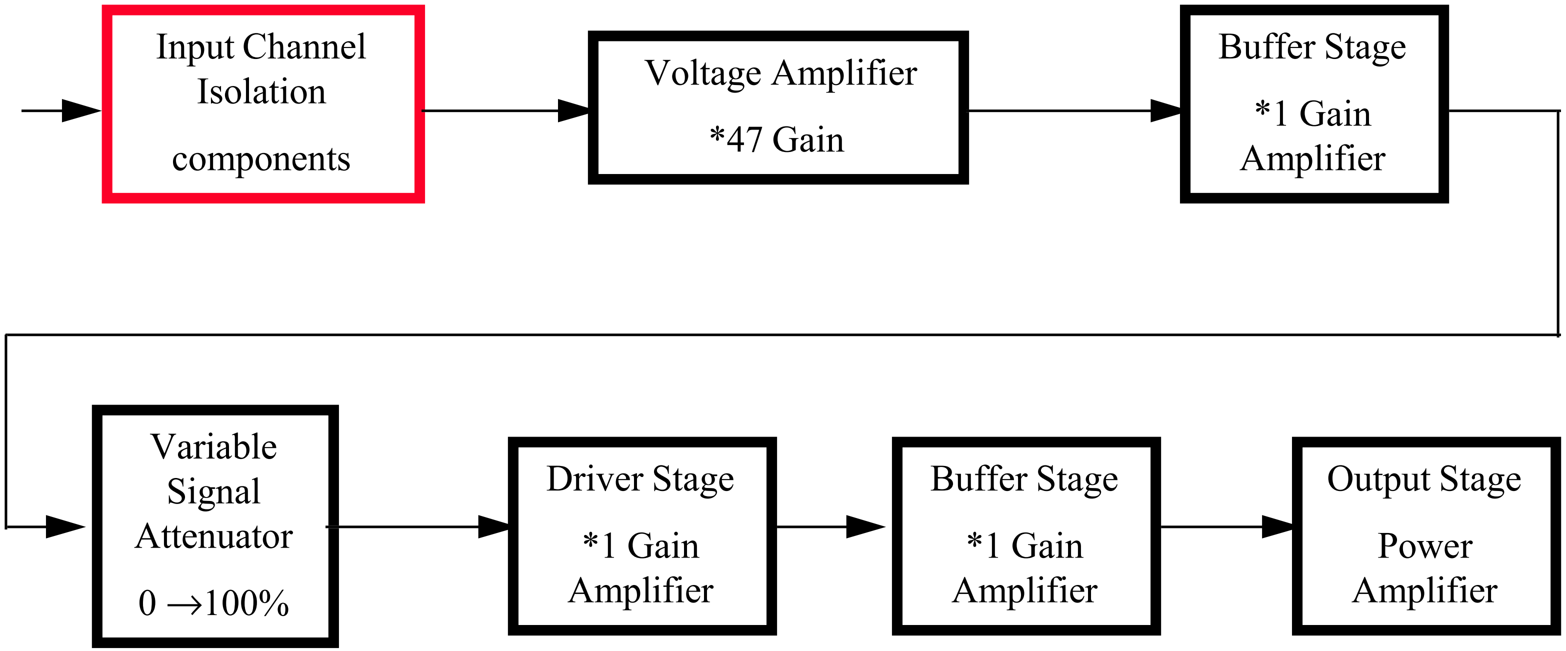
$$Xc = \frac{1}{2 * \pi * 100 * 10^{-6}} = \frac{10^{6}}{2 * \pi * 100} = 15.91\Omega$$

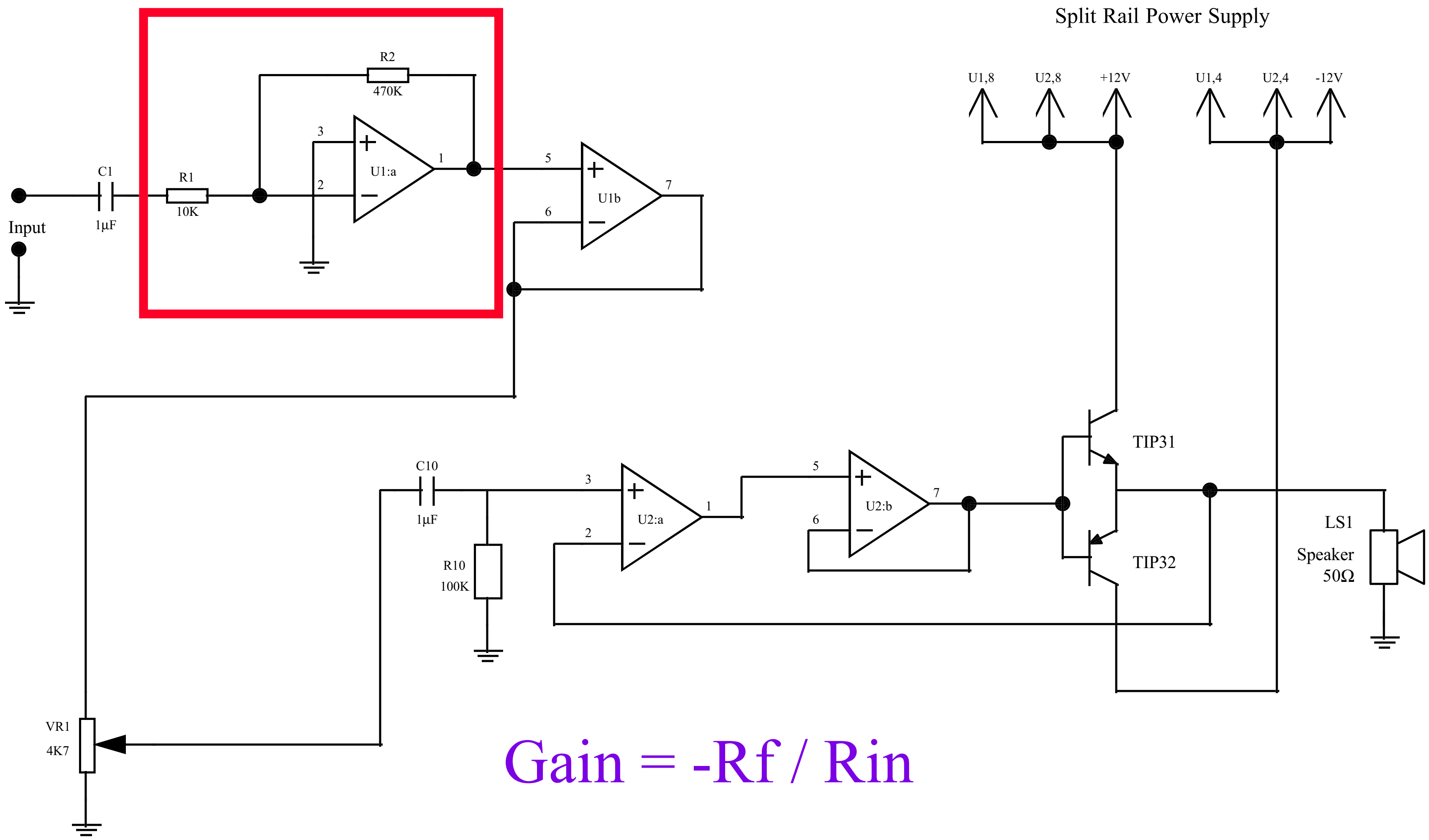
Capacitor coupling (DC Block).

Amplifier Theory.



Block Diagram.

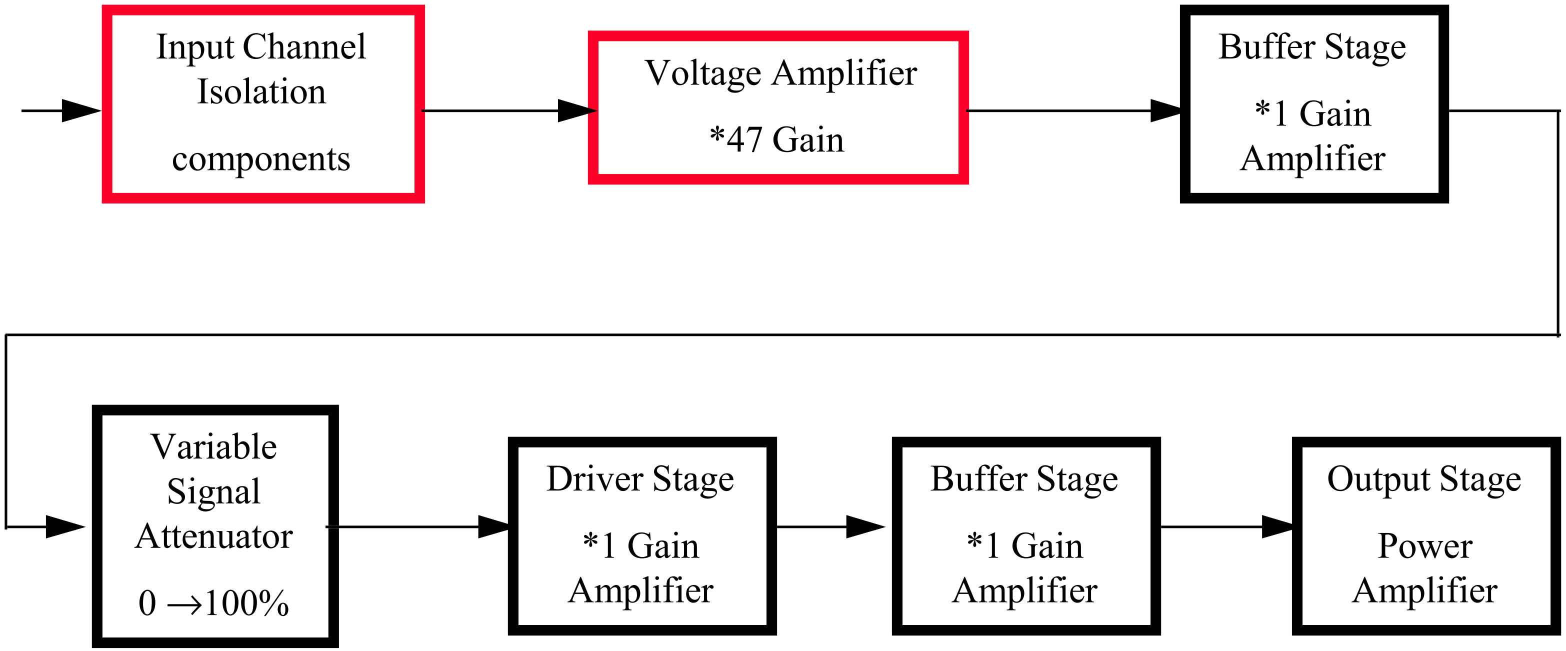
The Amplifier.



$$Gain = -Rf / Rin$$

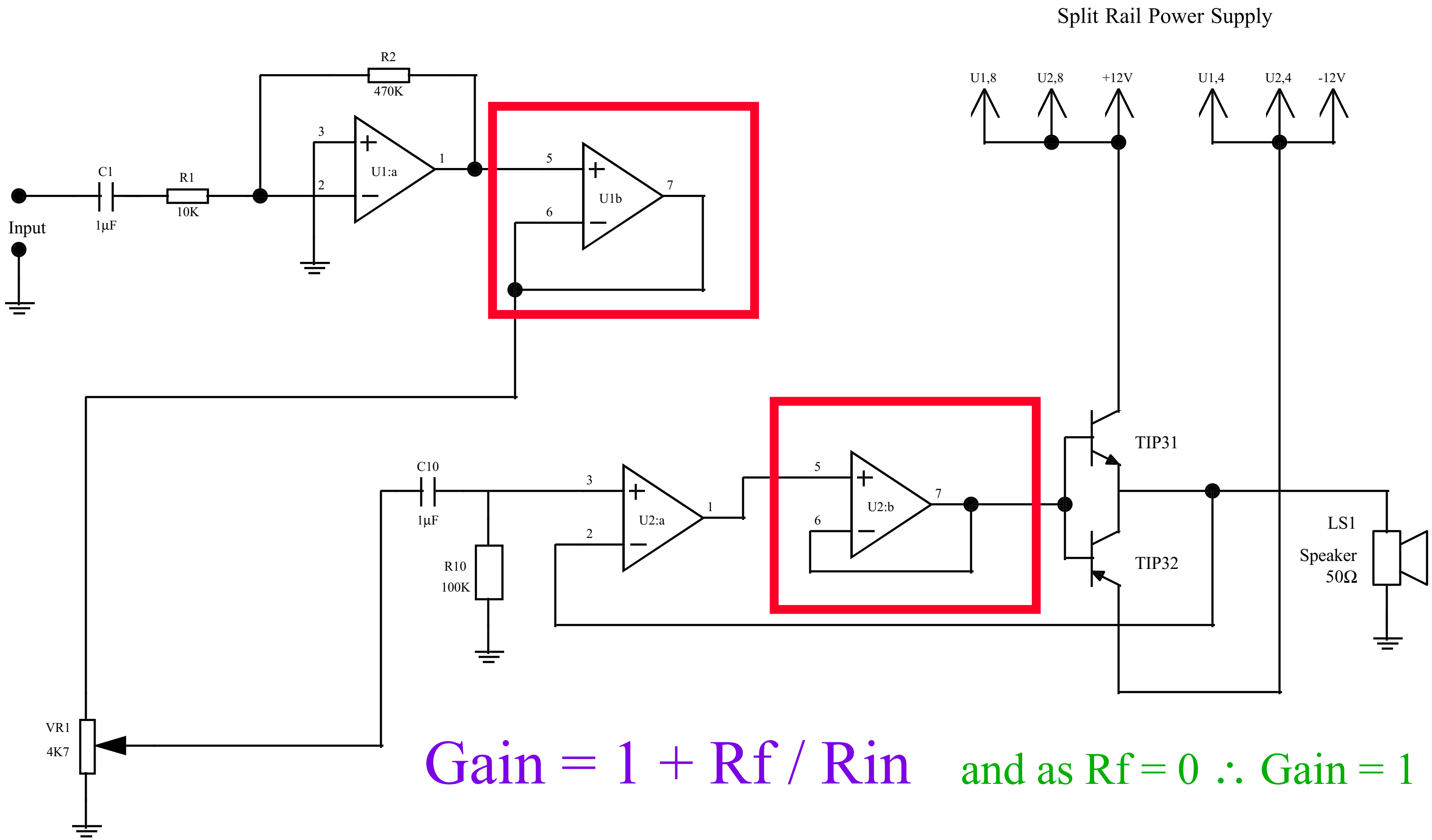
Signal Amplifier circuit.

Amplifier Theory.



Block Diagram.

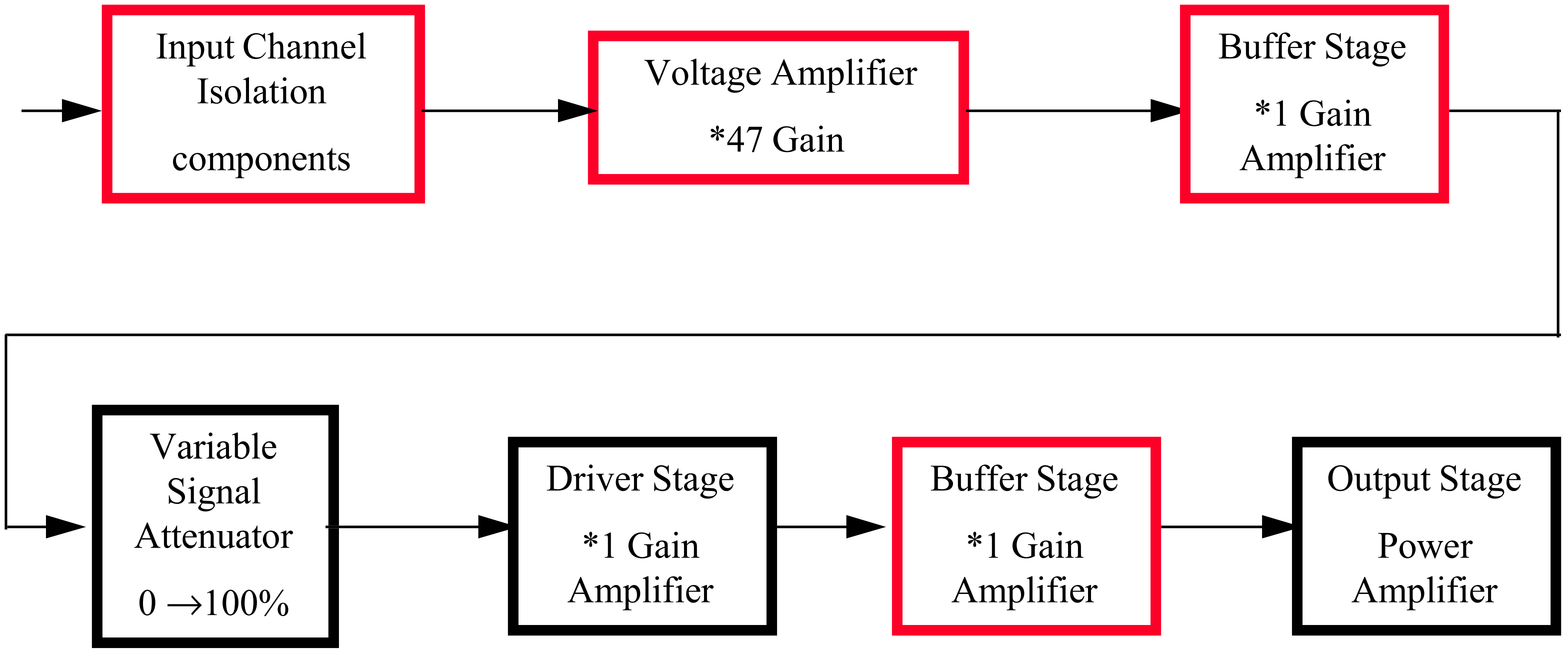
The Amplifier.



Gain = 1 + Rf / Rin   and as Rf = 0 ∴ Gain = 1

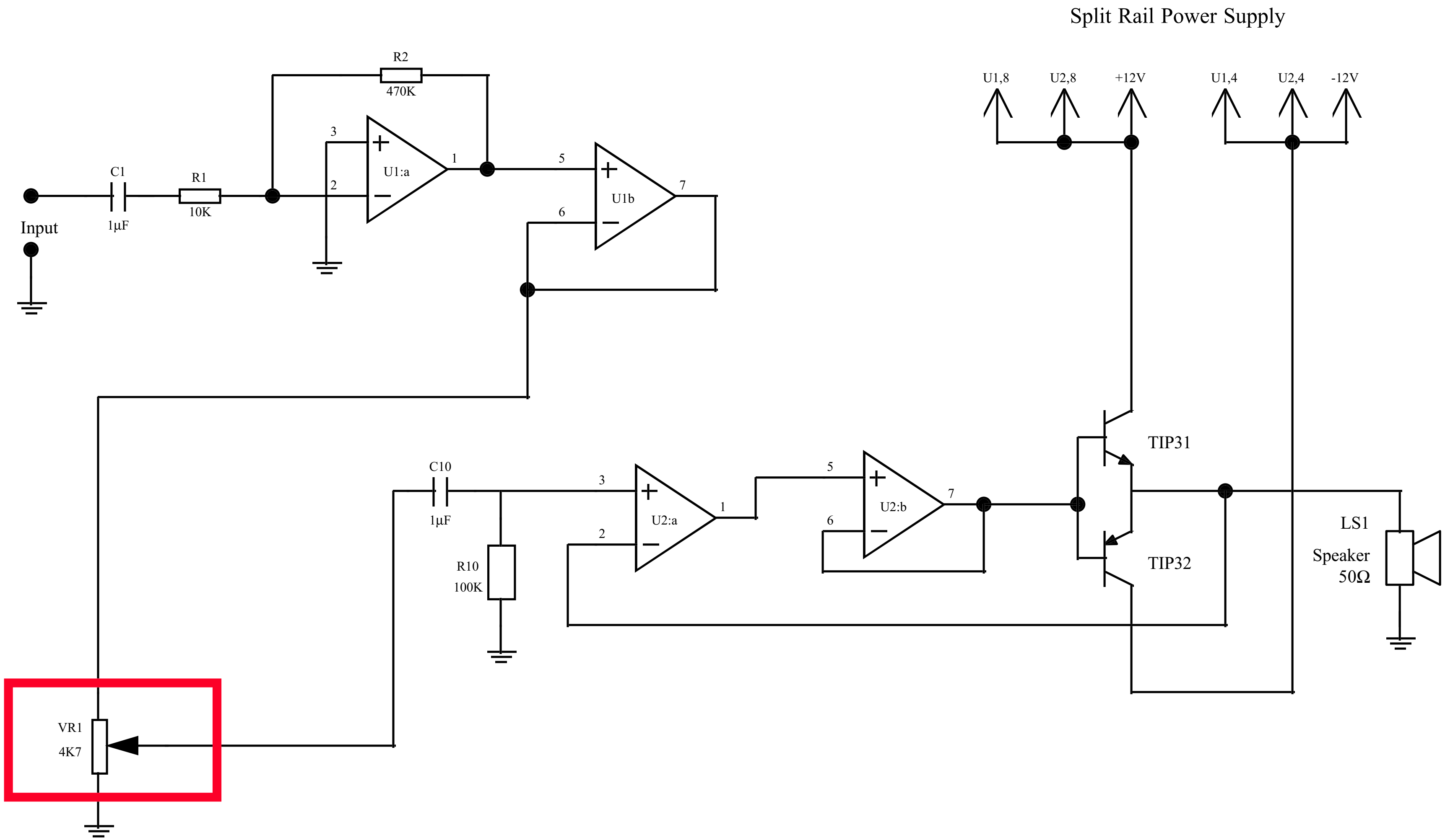
Buffer Stage (Signal Amplifier *1 Gain) circuit.

Amplifier Theory.



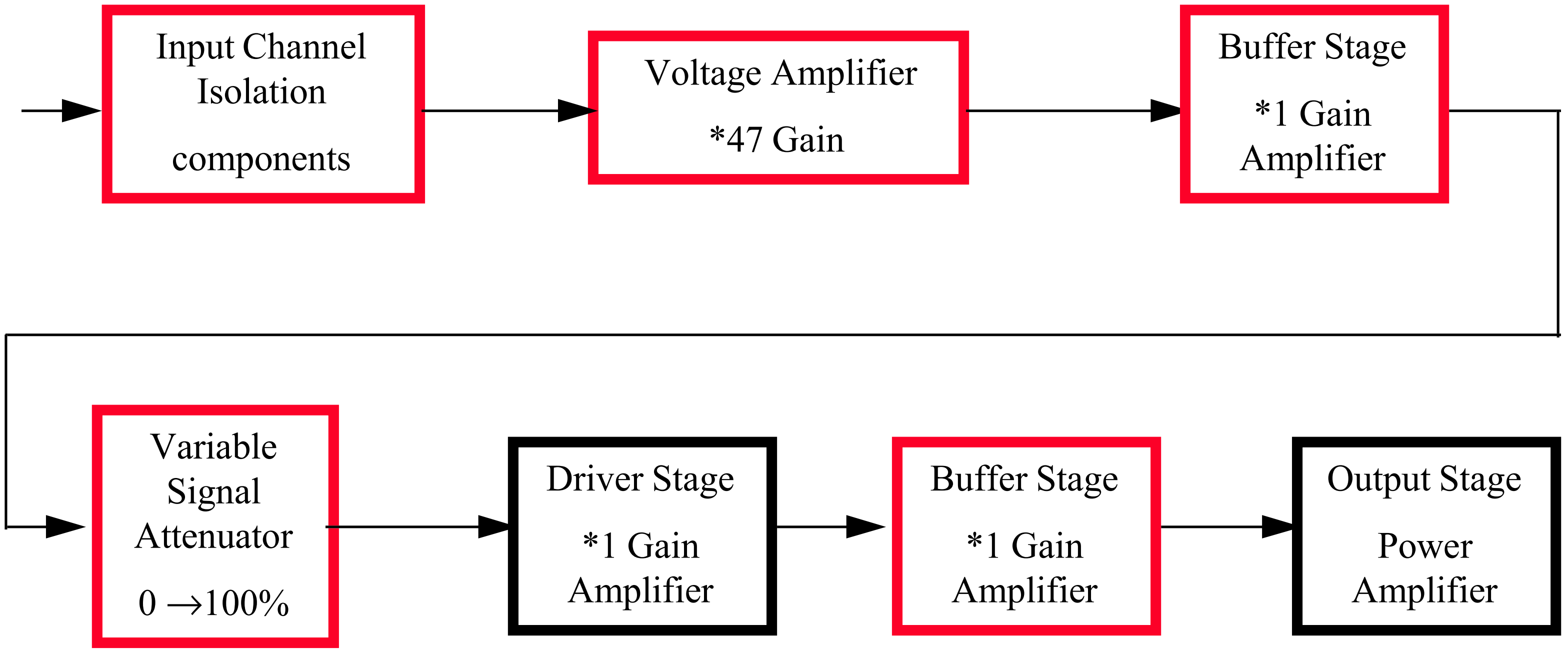
Block Diagram.

The Amplifier.



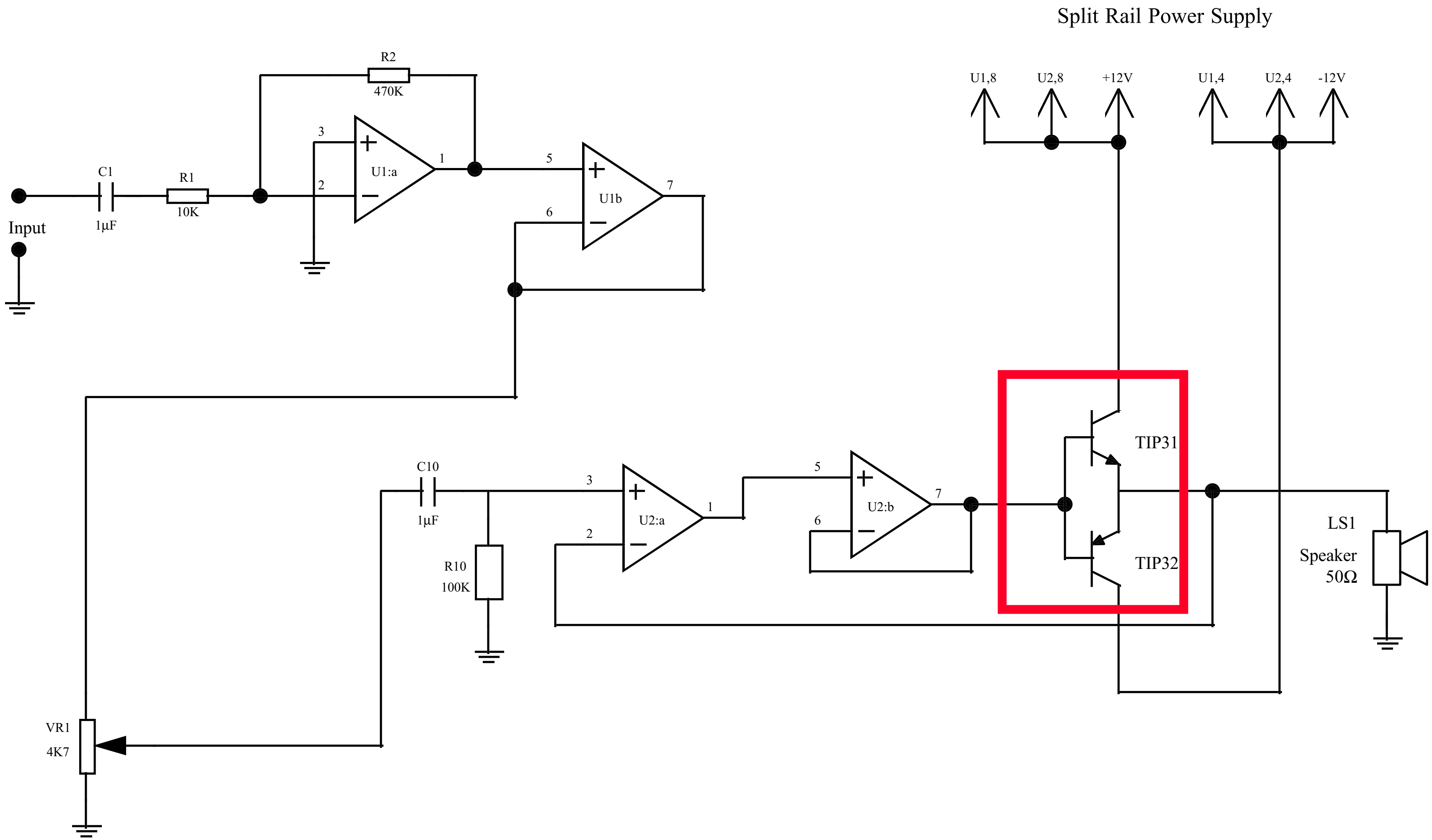
Signal Attenuator (Volume Control).

Amplifier Theory.



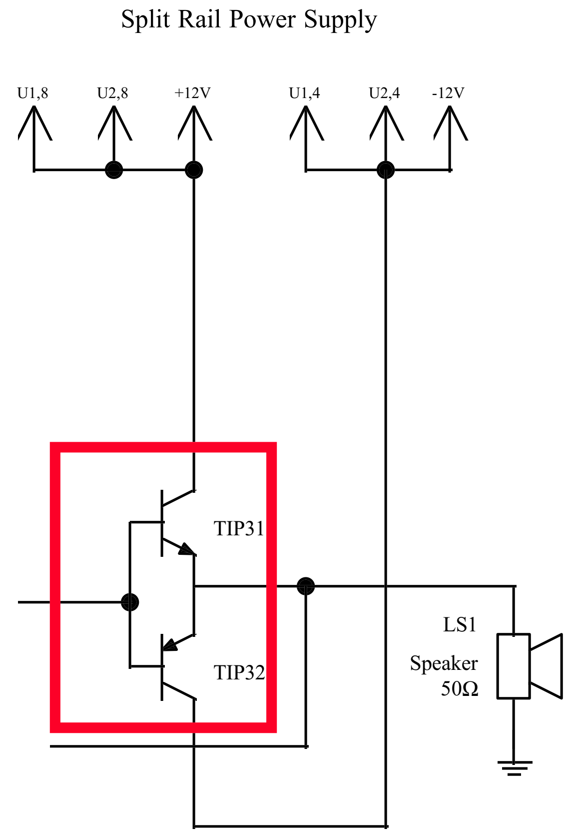
Block Diagram.

The Amplifier.



Power Driver circuit.

The Amplifier.



Power Driver circuit.

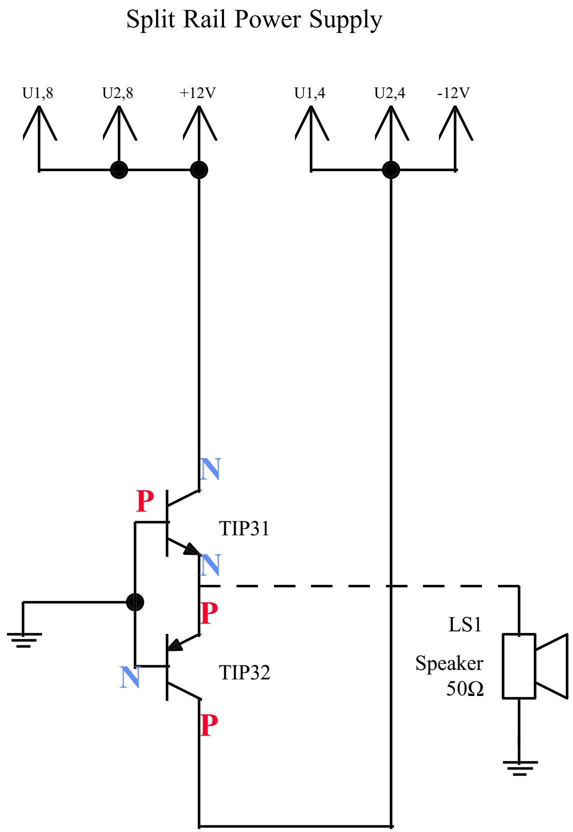
Amplifier Theory.

If Base connection is held at mid rail voltage then

TIP32 is Switched Off. (Will appear as O/C)
TIP31 is Switched Off. (Will appear as O/C)

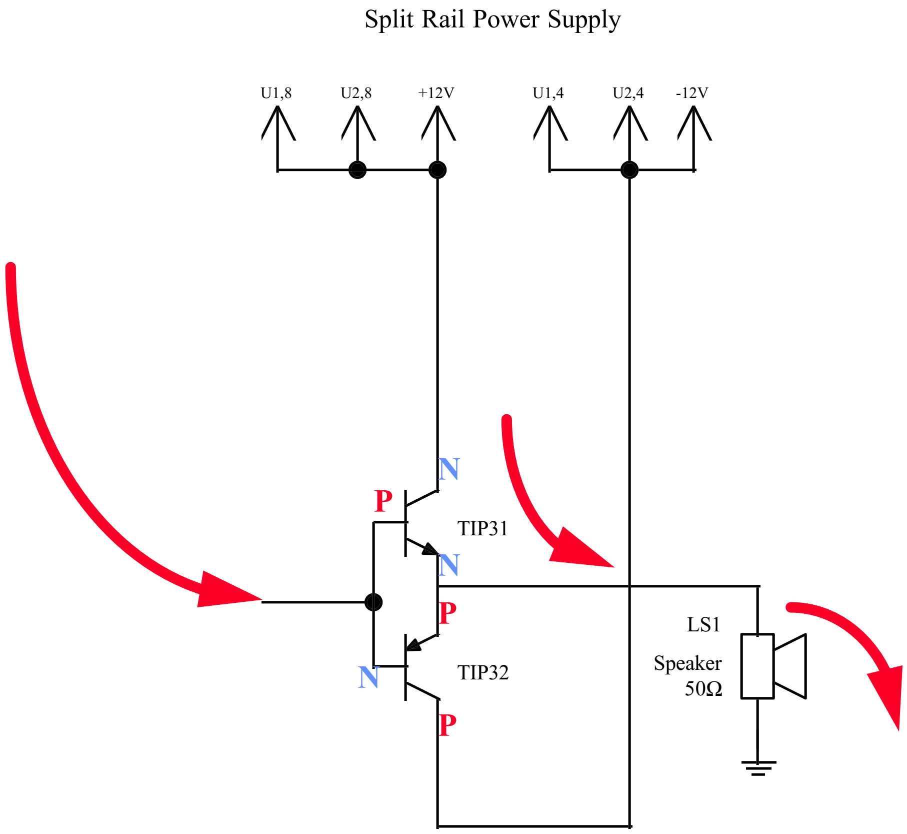
The Load Speaker Cone will remains in neutral position as no voltage will be present across it.

Remember that you need a voltage about 0.6 volts to switch a silicon transistor into a conducting state (Switched on).



Power Driver circuit.

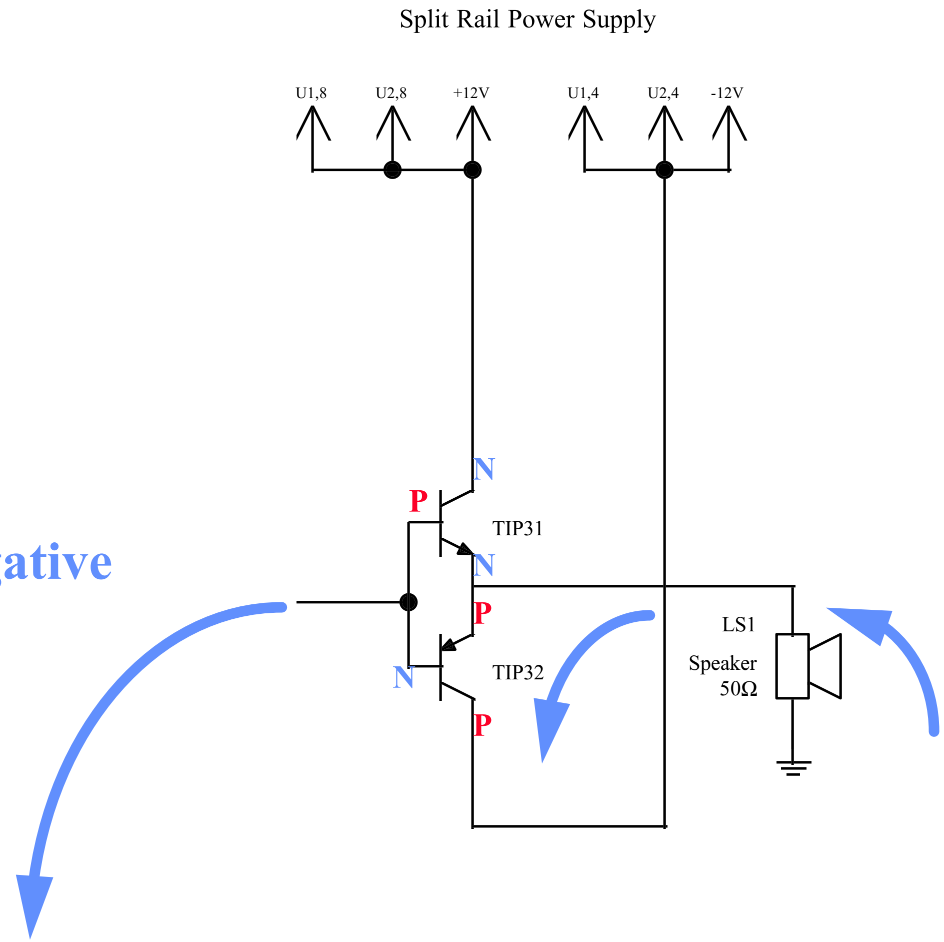
Amplifier Theory.



As Base connection goes more
Positive
TIP31 Conducts.
TIP32 is Switched Off.
Load Speaker Cone Pushes Forward.

Power Driver circuit.

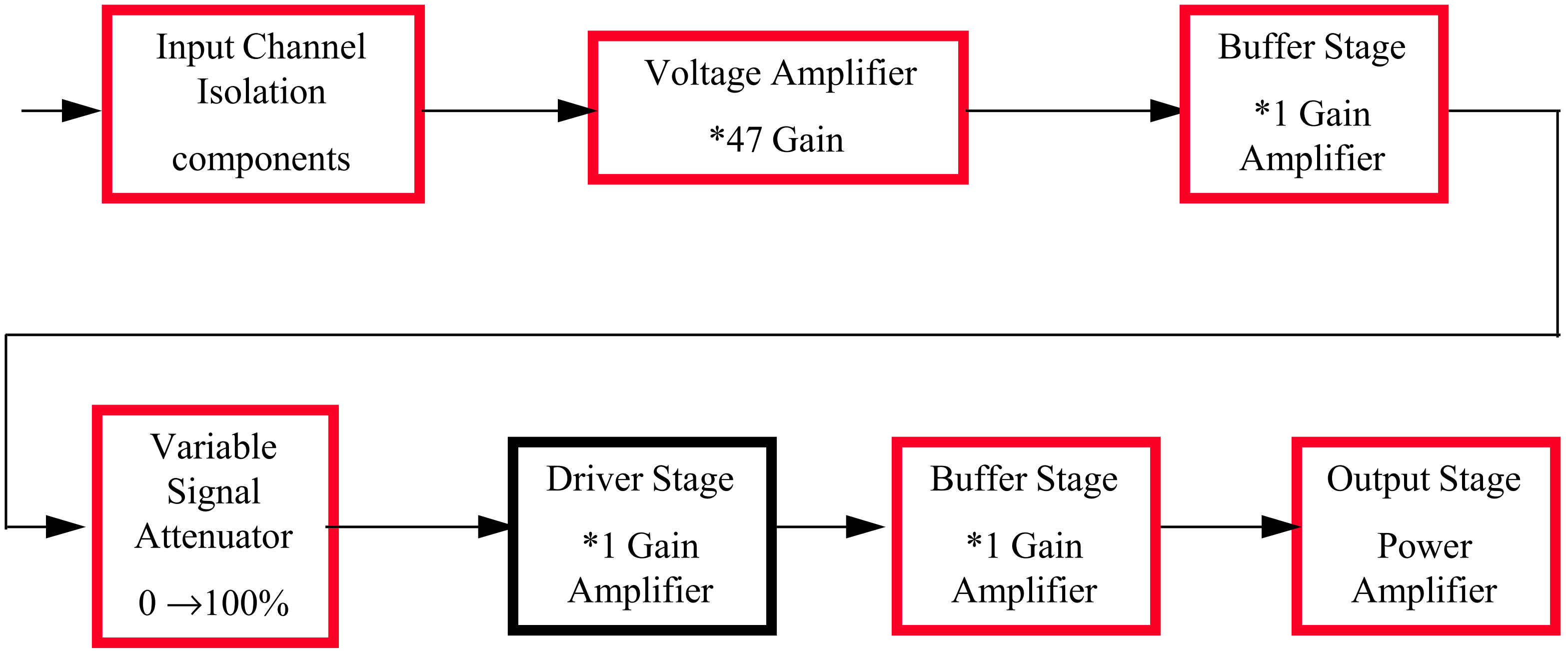
Amplifier Theory.



As Base connection goes more **Negative**
TIP32 Conducts.
TIP31 is Switched Off.
Load Speaker Cone Pulls Back.

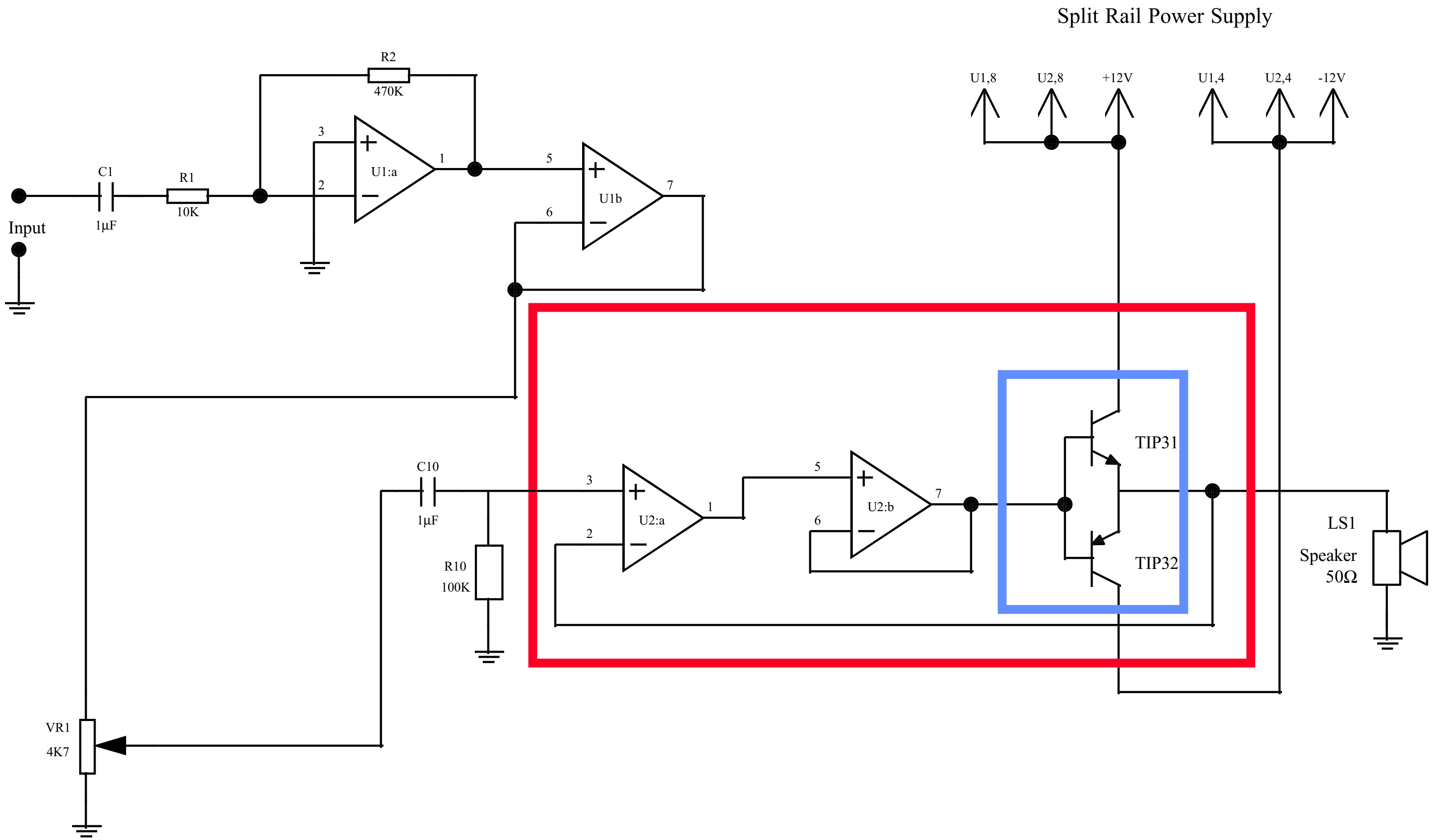
Power Driver circuit.

Amplifier Theory.



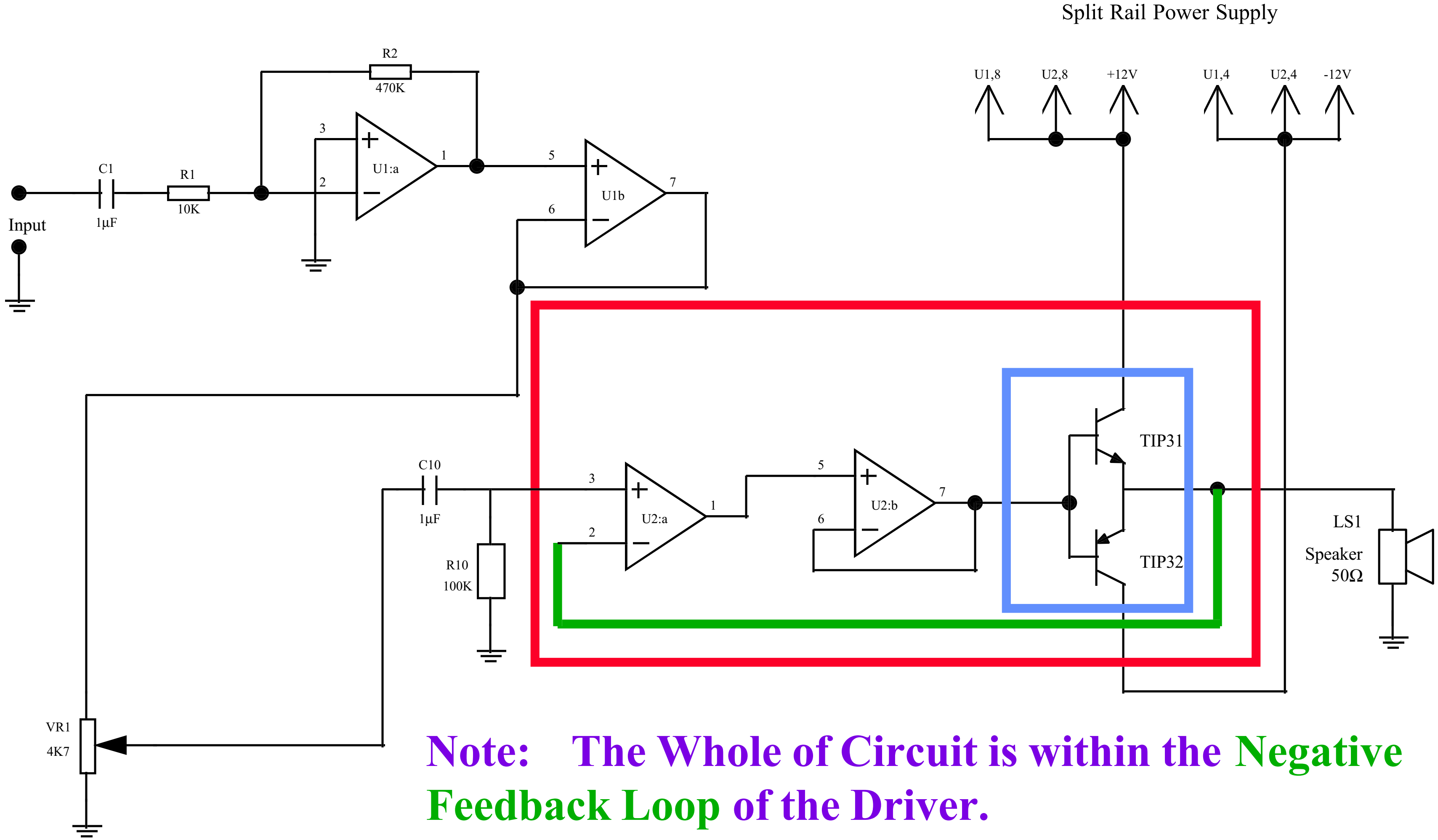
Block Diagram.

The Amplifier.



Voltage Follower "Driver" & Power Amplifier circuit.

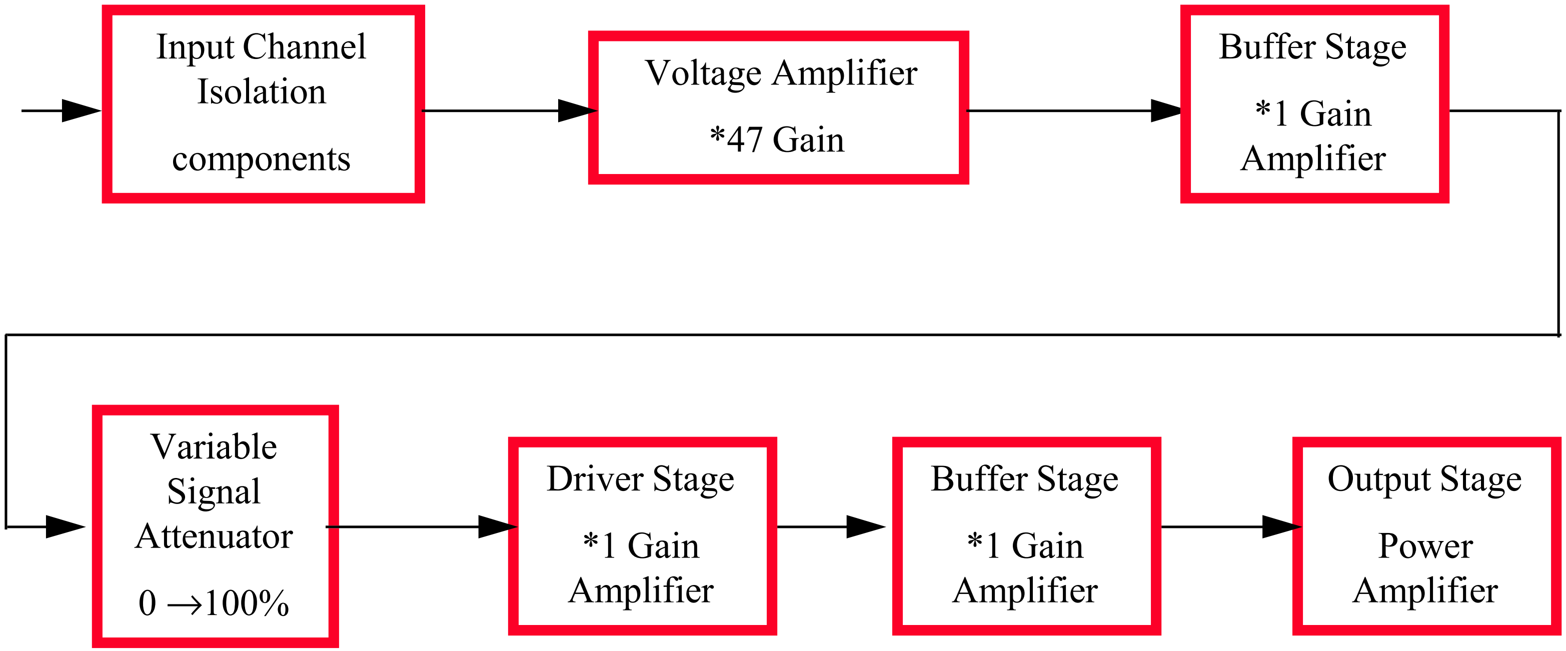
The Amplifier.



Note: The Whole of Circuit is within the Negative Feedback Loop of the Driver.

Voltage Follower "Driver" & Power Amplifier circuit.

Amplifier Theory.



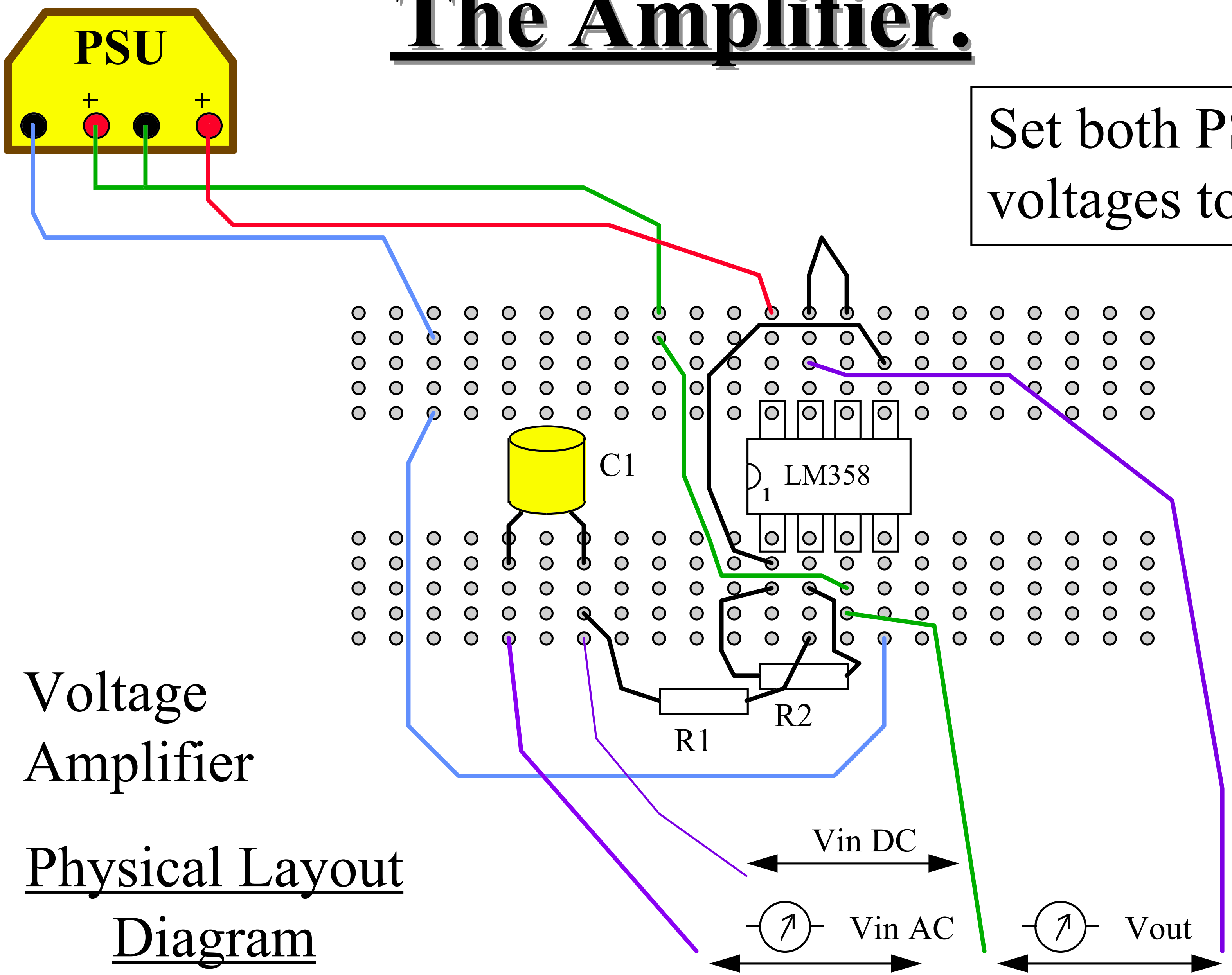
Block Diagram.

Amplifier Building

Amplifier Circuit checking.

- Check that ICs are correct way round and in the correct place.
- Check that Transistors are correct way round and in the correct place.
- Verify all resistor are in correct place and correct value.
- Verify all capacitors are in correct place and correct value.
- Verify that your “NET” list matches your Breadboard construction.

The Amplifier.



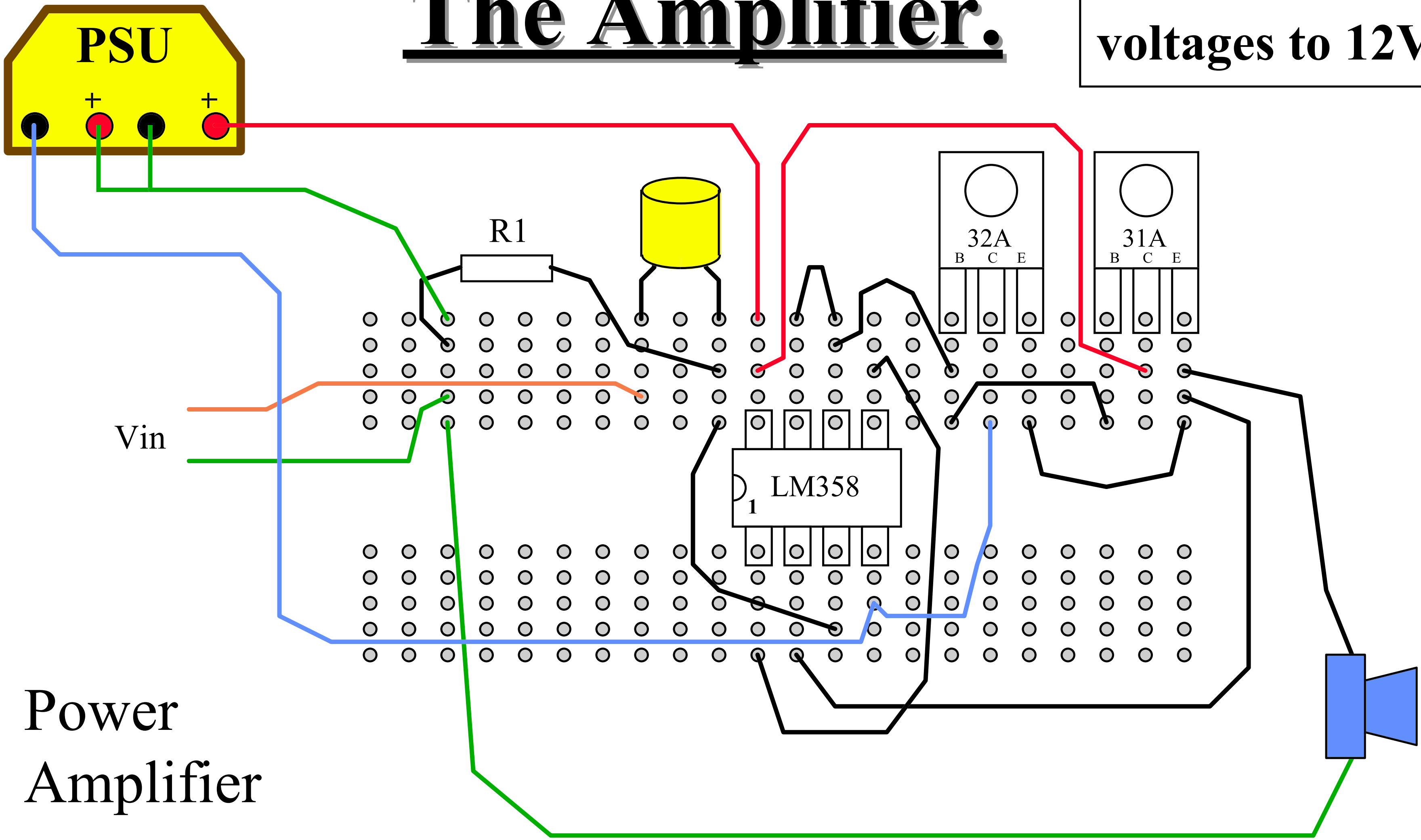
Set both PSU voltages to 12V

Voltage Amplifier

Physical Layout Diagram

The Amplifier.

Set both PSU voltages to 12V

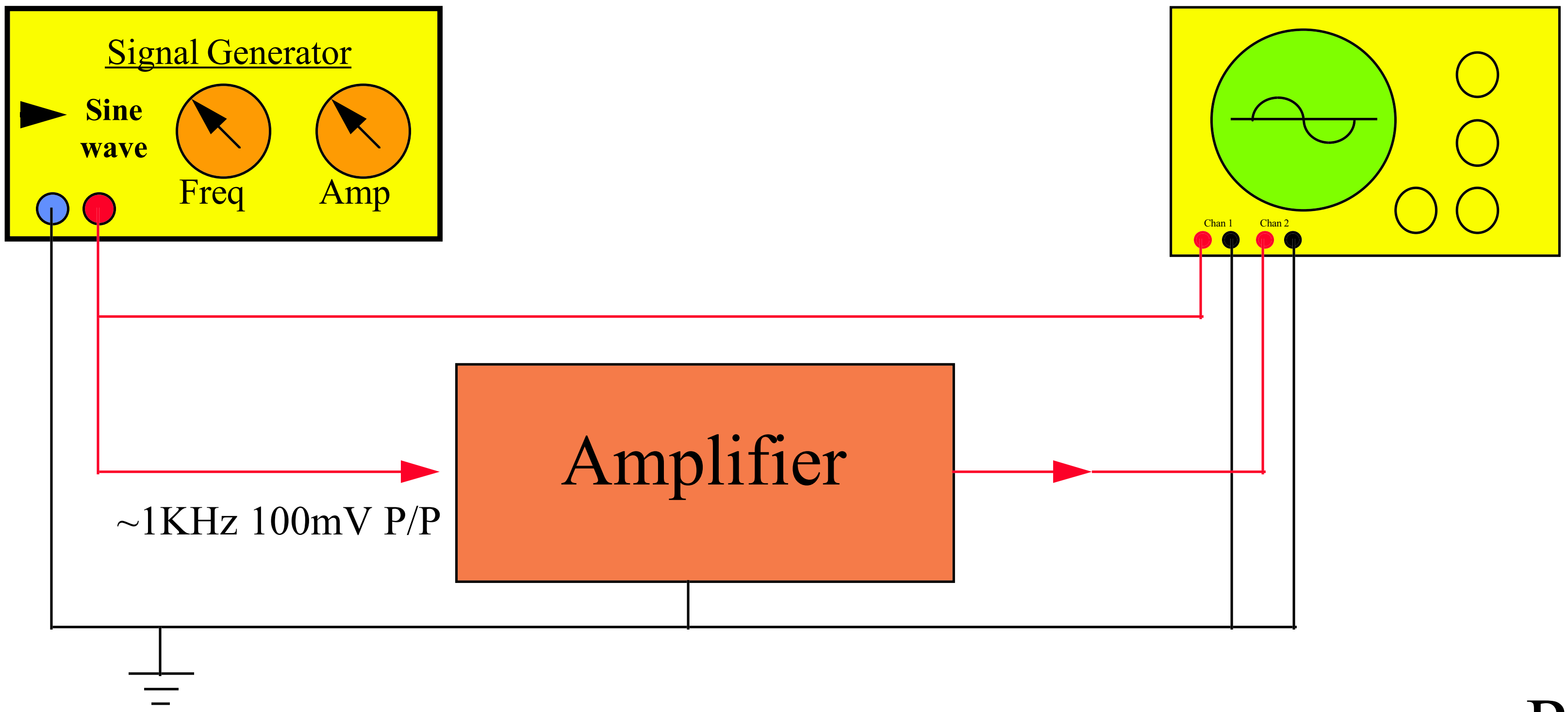


Power Amplifier

Physical Layout Diagram

Amplifier Testing

The Amplifier Testing (AC).



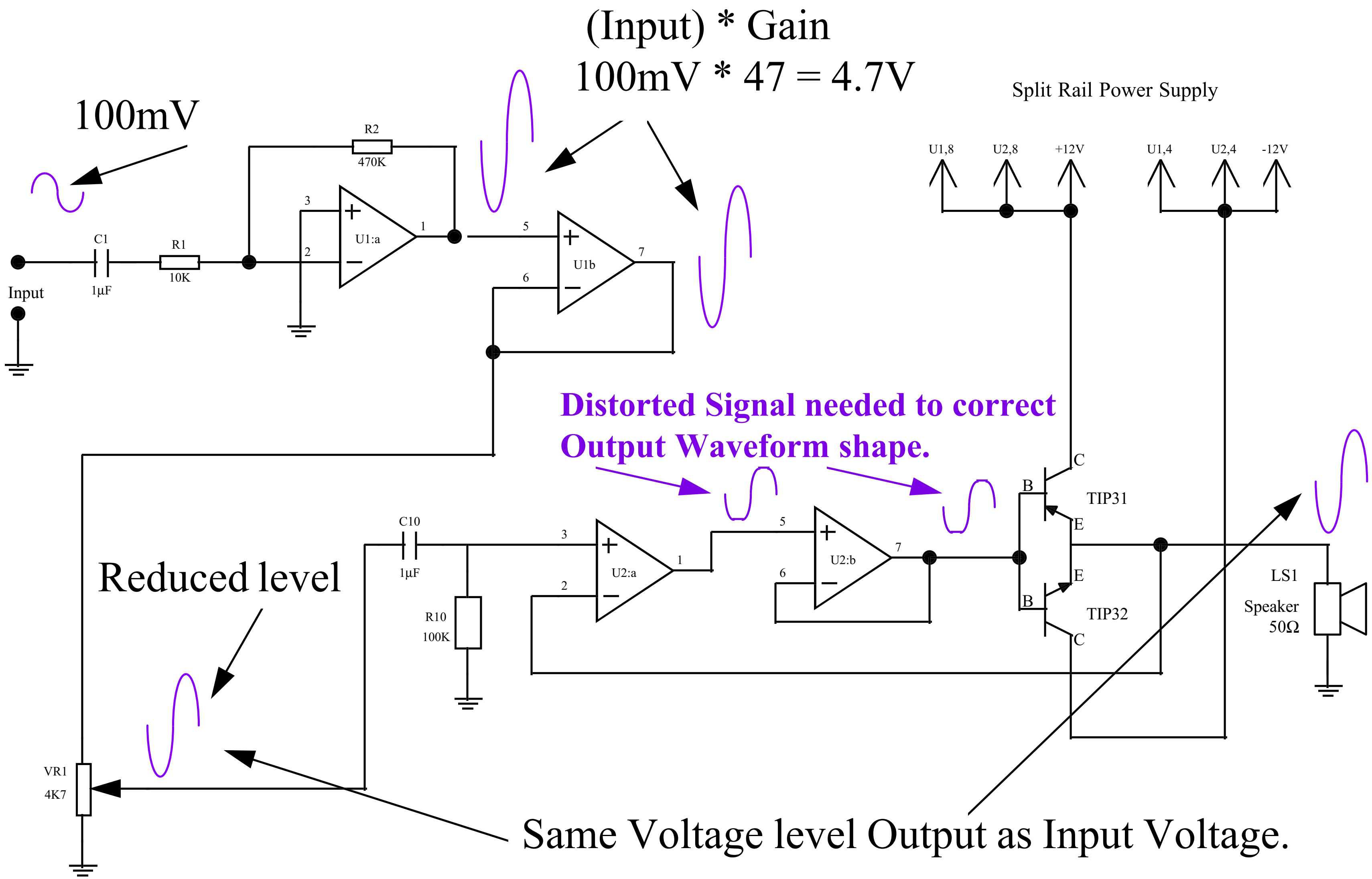
Calculate Gain.

Measure Gain.

Compare Results (Do they match) ?

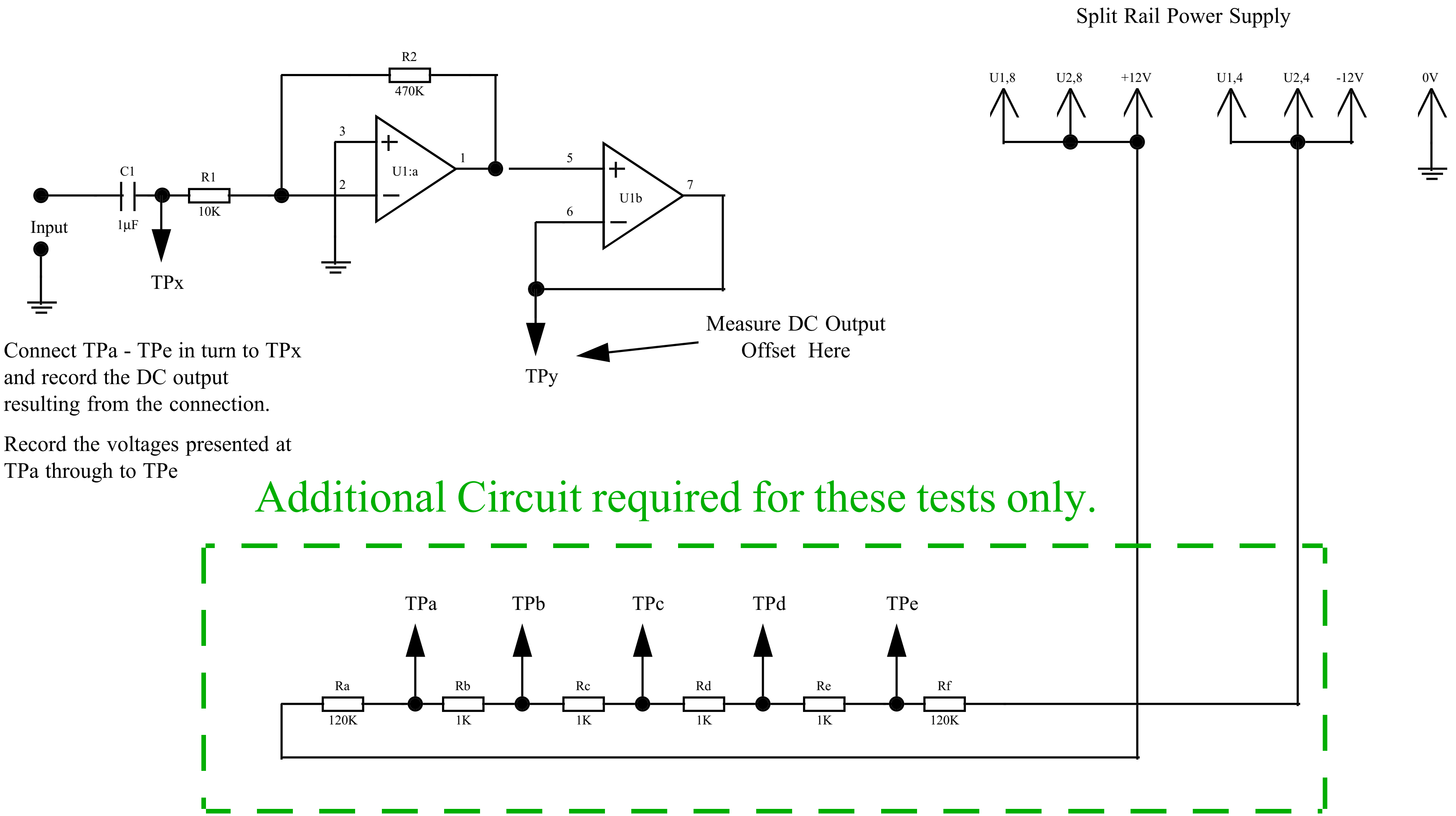
$$\text{Gain} = \frac{\text{V Output}}{\text{V Input}} = \frac{-\text{Rf}}{\text{Rin}}$$

The Amplifier.



Signals through the Amplifier circuit.

The Amplifier Testing (DC).



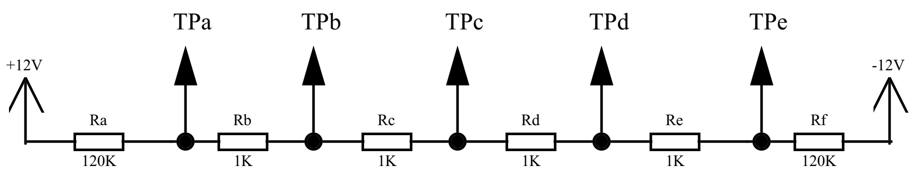
Connect TPa - TPe in turn to TPx and record the DC output resulting from the connection.

Record the voltages presented at TPa through to TPe

DC Voltage Tests for Voltage amplifier circuit.

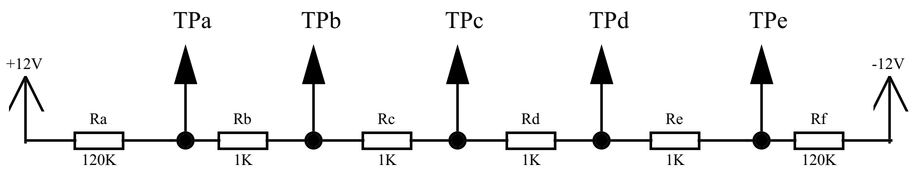
The Amplifier Testing (DC).

- Calculate total voltage across resistor circuit.
- Left hand side = +12V : Right hand side = -12V
- Difference = +12V - (-12V) = 24V
- Calculate total resistance of circuit
- RTs = R1 + R2 + R3 ....
- RTs = 120K + 1K + 1K + 1K + 1K +120K =244K
- Calculate current in circuit ie. I = V/R
- Icct = 24V / 244K = 24/244000 A



The Amplifier Testing (DC).

- Calculate voltage across resistors Ra or Rf.
- $V = I*R \therefore VR_{(a,f)} = 24/244000 * 120000 = (24*120)/244 = 2880/244$ Volts 11.803V
- Calculate voltage across resistors Rb,Rc,Rd or Re.
- $V = I*R \therefore VR_{(b-e)} = 24/244000 * 1000 = (24*1)/244 = 24/244$ Volts 0.0984V
- Note: Sum of the voltages is $2*(2880/244) + 4*(24/244) = (5760+96)/244 = 5856/244 = 24$



The Amplifier Testing (DC).

- Calculate voltage across resistors Ra or Rf.
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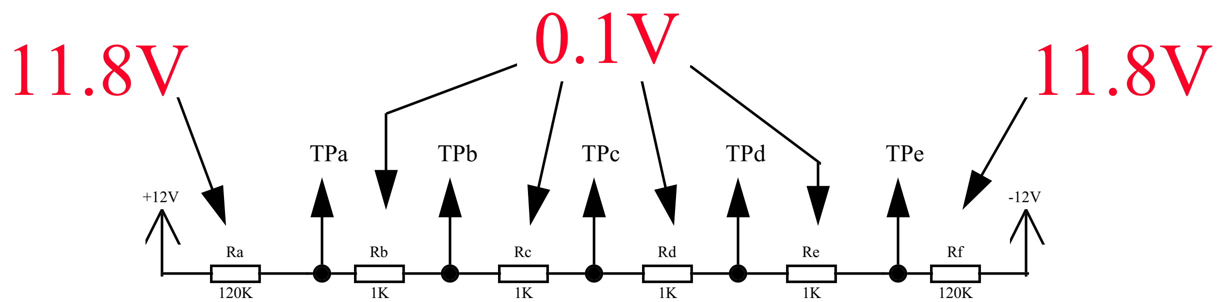
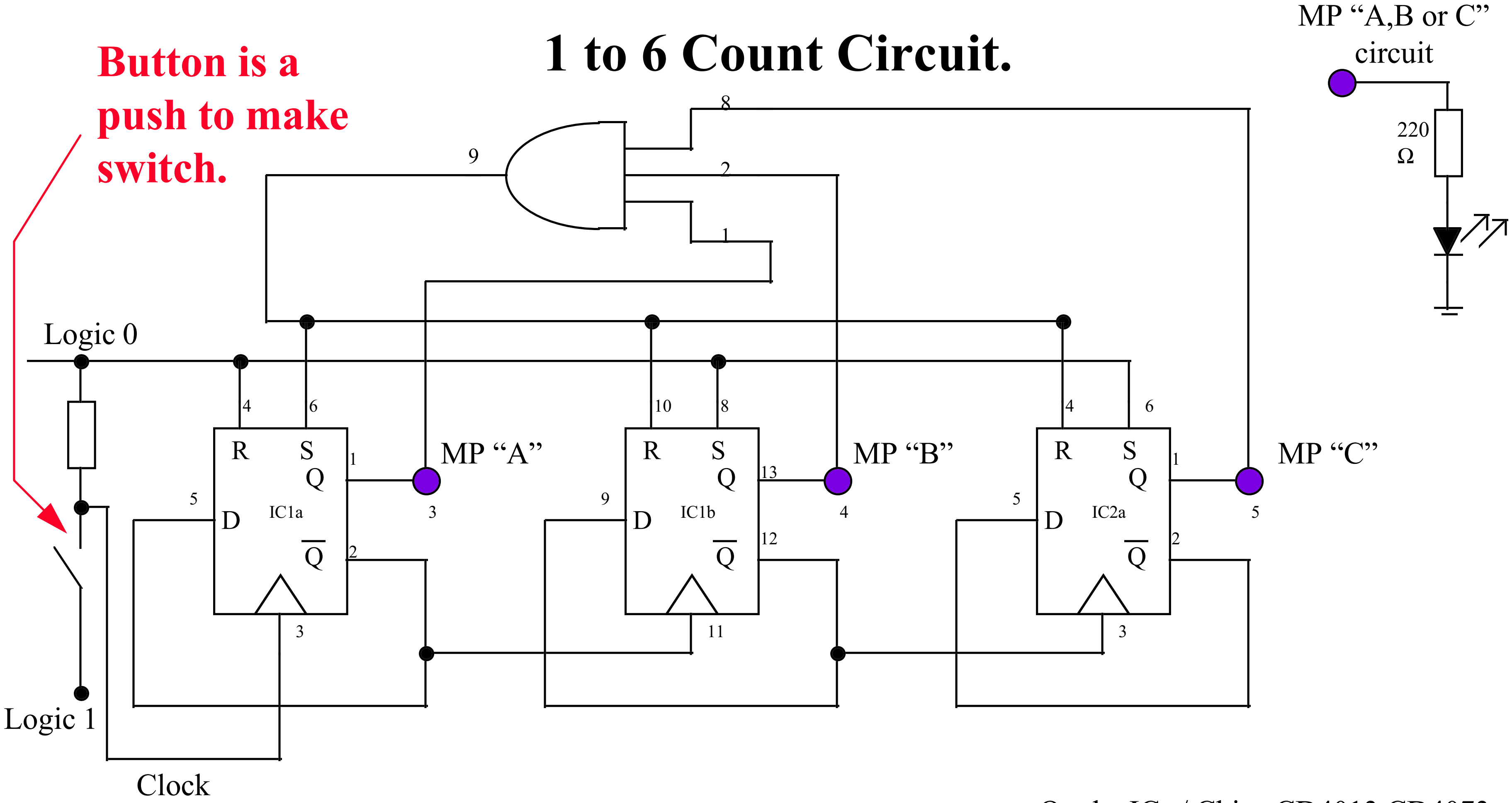


Simulation

Digital Dice Counter Circuit.

1 to 6 Count Circuit.



On the ICs / Chips CD4013 CD4073

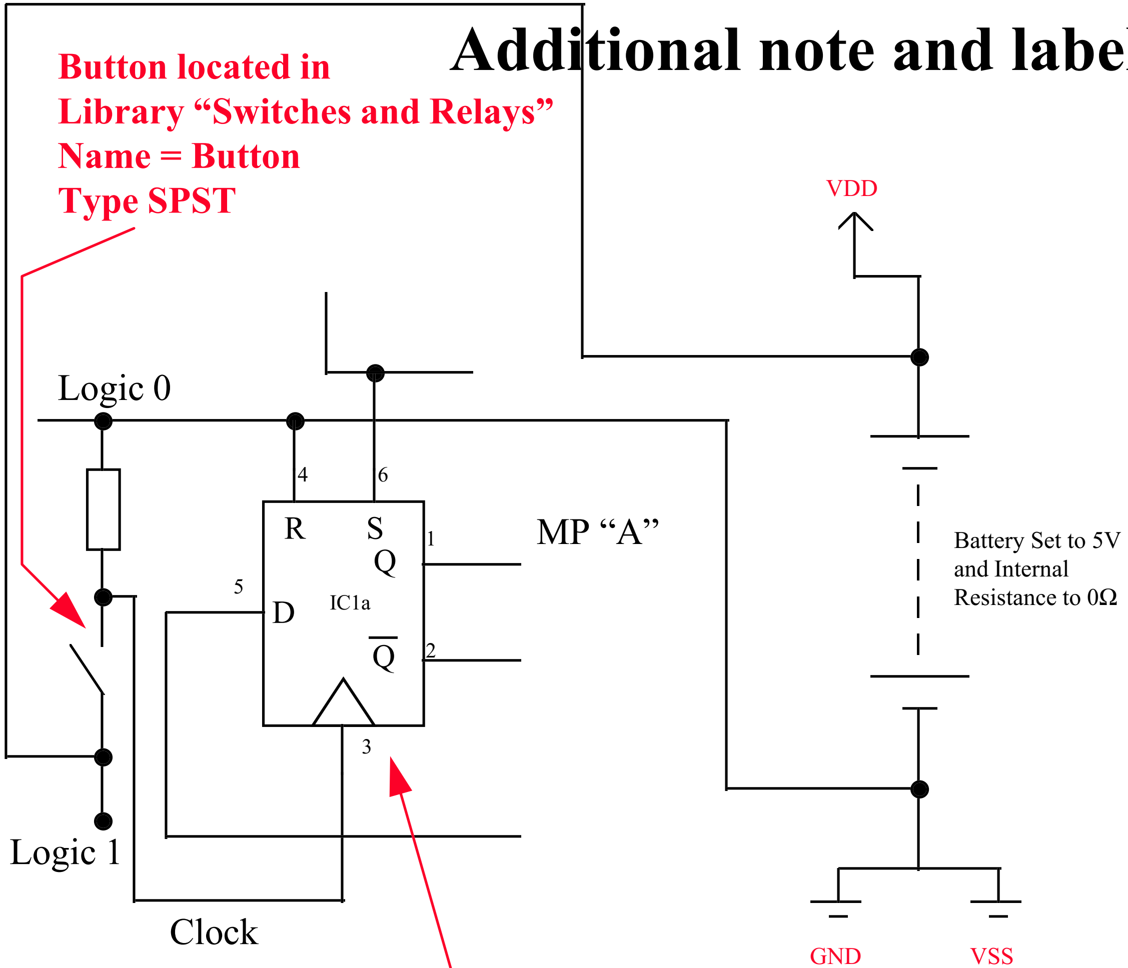
Connect VSS to Ground/0V Logic 0

Connect VDD to +5V Logic 1

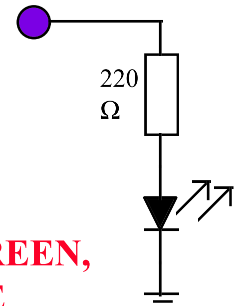
Digital Dice Counter Circuit.

Additional note and labels required.

Button located in
Library "Switches and Relays"
Name = Button
Type SPST



MP "A,B or C" circuit



LED located in
Library "Optoelectronics"
Name = LED-RED, LED-GREEN, LED-YELLOW, LED-BLUE

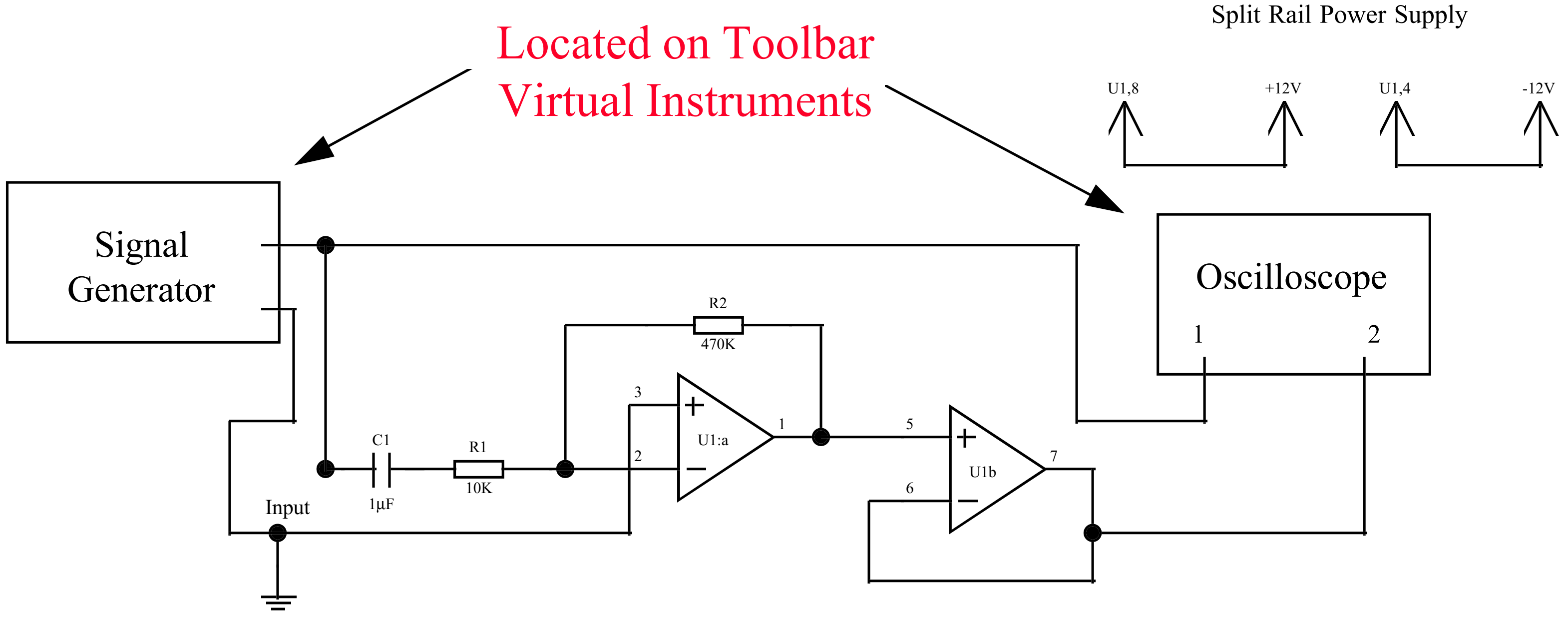
Battery located in
Library "Simulator Primitives"
Name = BATTERY

Resistor located in
Library "Modelling Primitives"
Name = RESISTOR

Devices located in
Library "CMOS 4000 series"
Name = 40... etc.

			On the ICs / Chips CD4013 CD4073
7	7	7	Connect VSS to Ground/0V Logic 0
14	14	14	Connect VDD to +5V Logic 1

The Amplifier.



Device located in
Library "Operational Amplifiers"
Name = LM358.
Look for the Chip with a <u>Spice model</u>

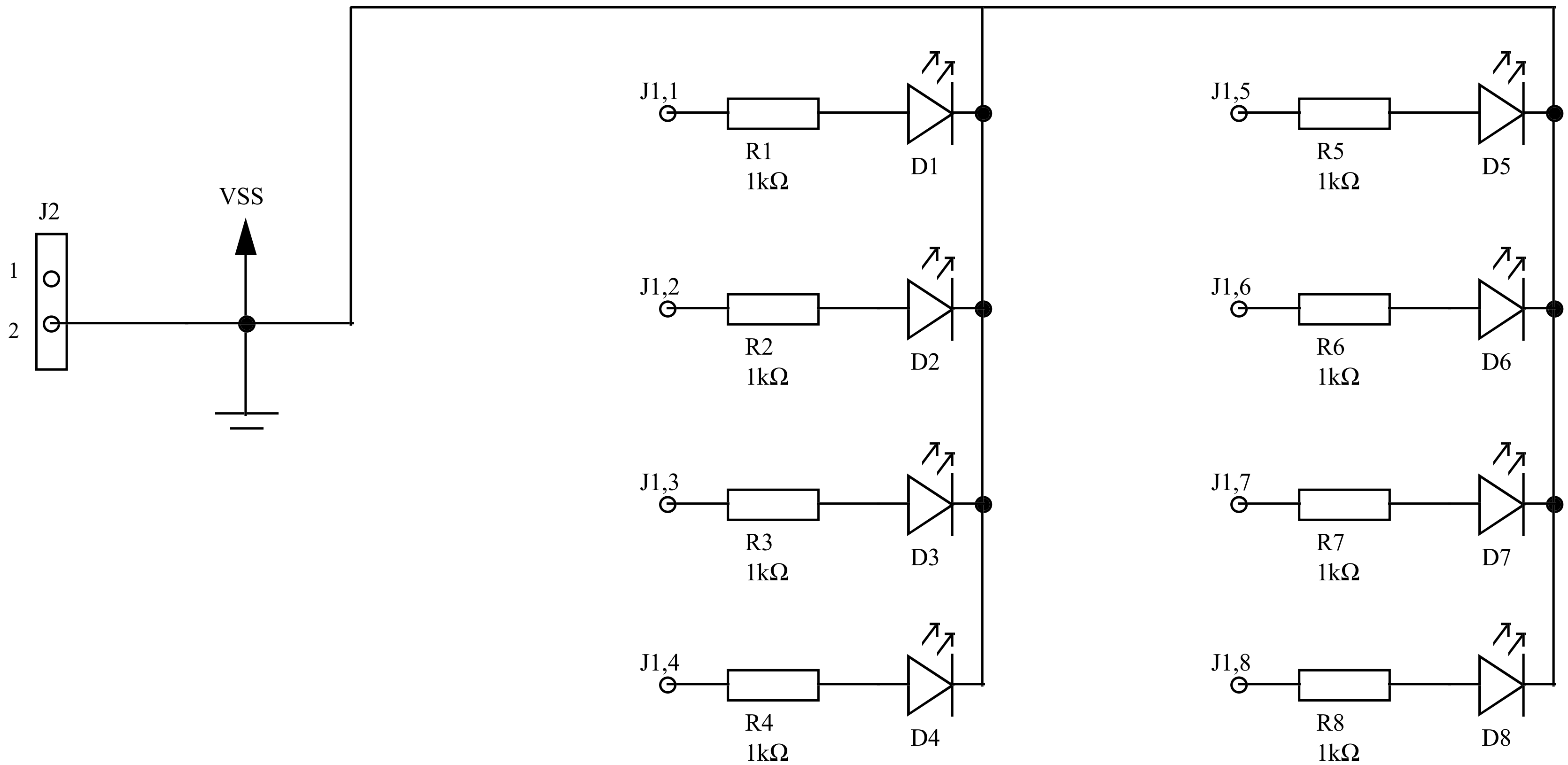
Resistor and Capacitor located in
Library "Modelling Primitives"
Name = RESISTOR , CAPACITOR

Voltage Amplifier circuit.

Microprocessors.

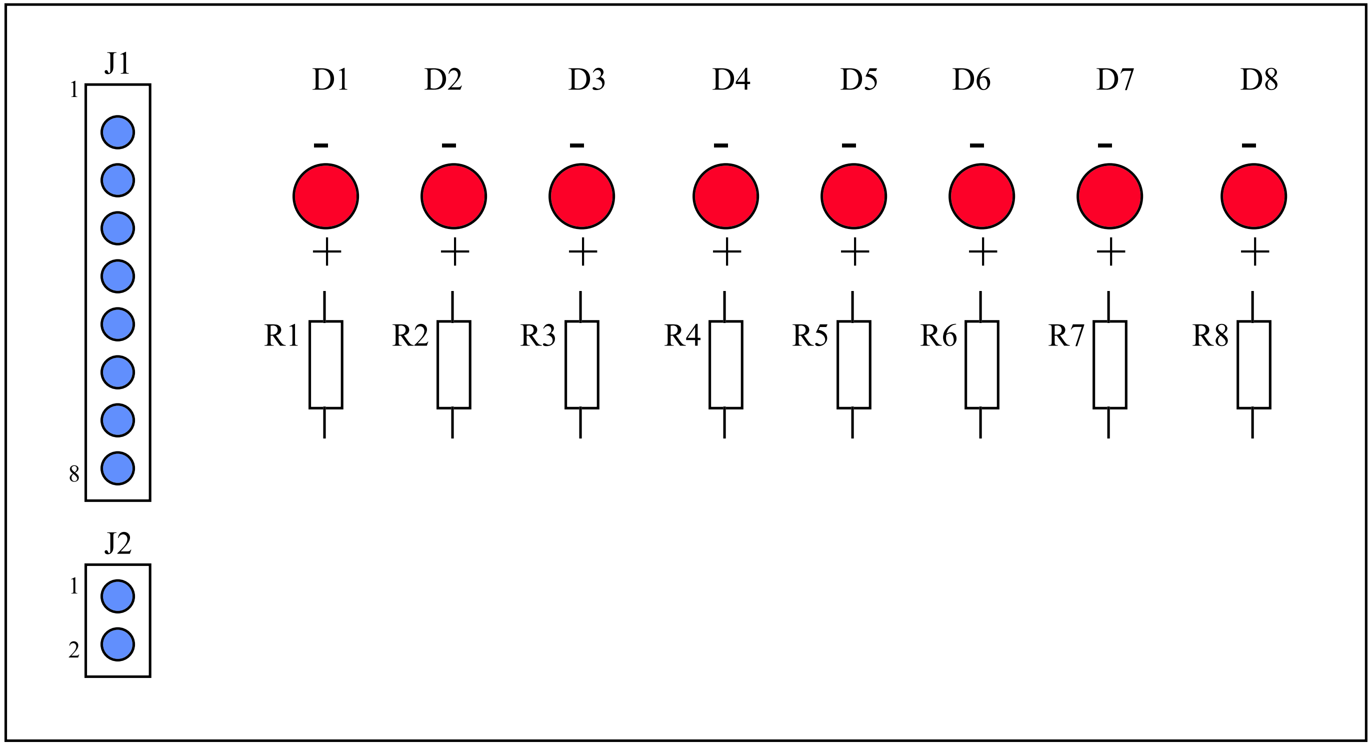
LED Display Board

LED Display Board.



Circuit of LED Display Board.

LED Display Board.



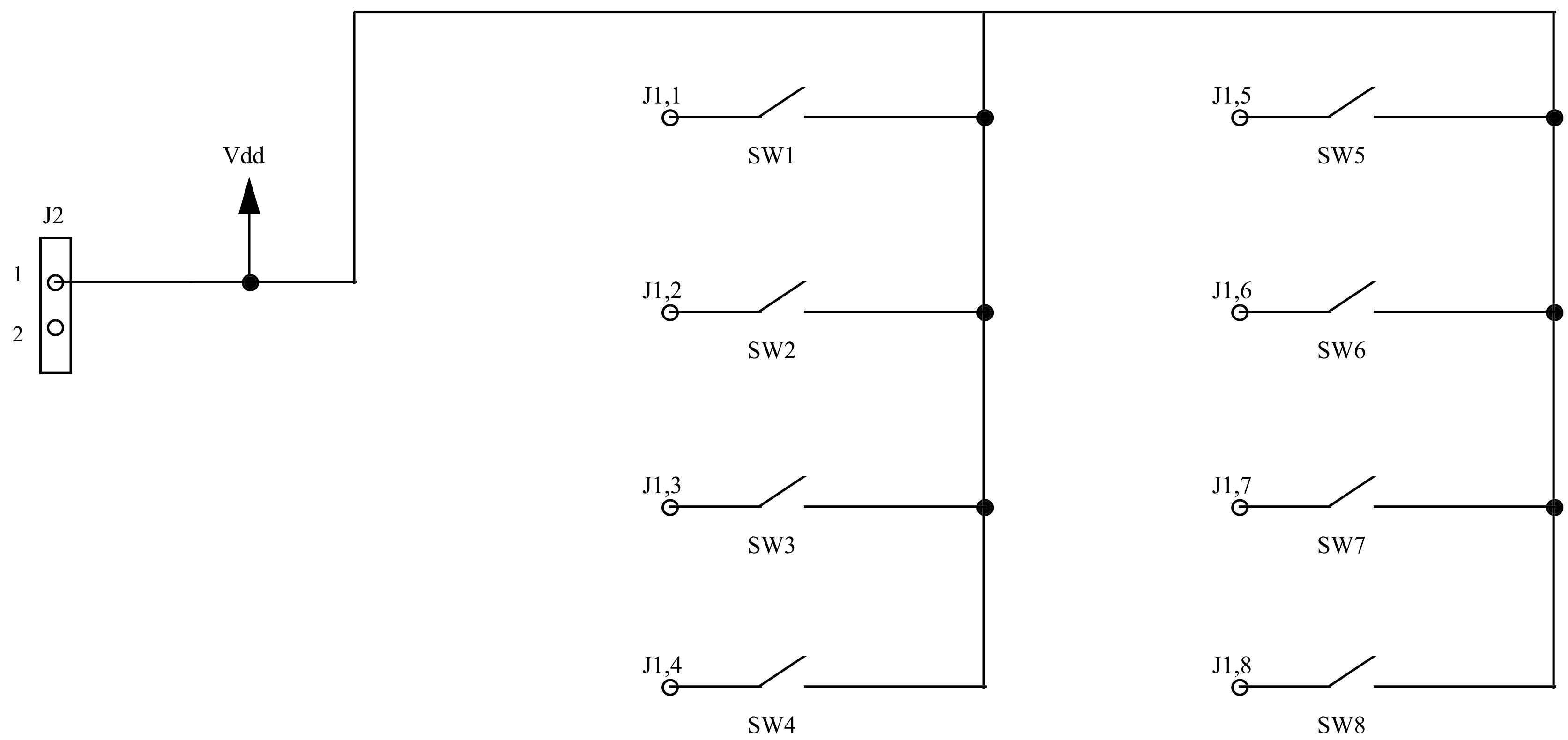
Layout of LED Display Board.

Testing LED Display Board.

- Check all solder connections (Shiny, Concave, No lumps bumps holes)
- Have all Components been located in the correct place the right way round.
- Verify that all tracks connect to the correct place and no additional short circuits added.
- Connect J2,2 to Ground
- and apply +5V to J1,1 and D1 should light.
- Repeat J1,2 ... ,8 → and D2...,D8 should light.

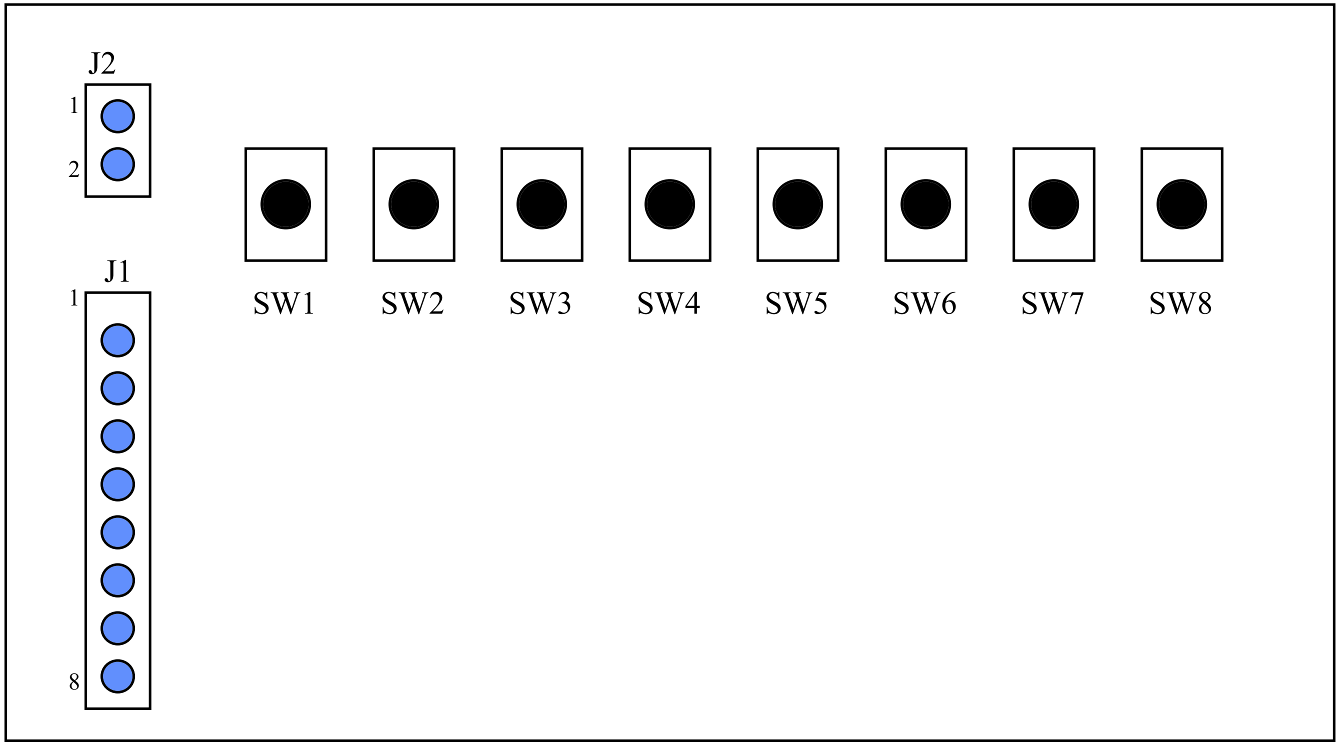
Push Button Array

Push Button Array Board.



Circuit of Push Button Array Board.

Push Button Array Board.



Layout of LED Push Button Array Board.

Testing Push Button Array Board.

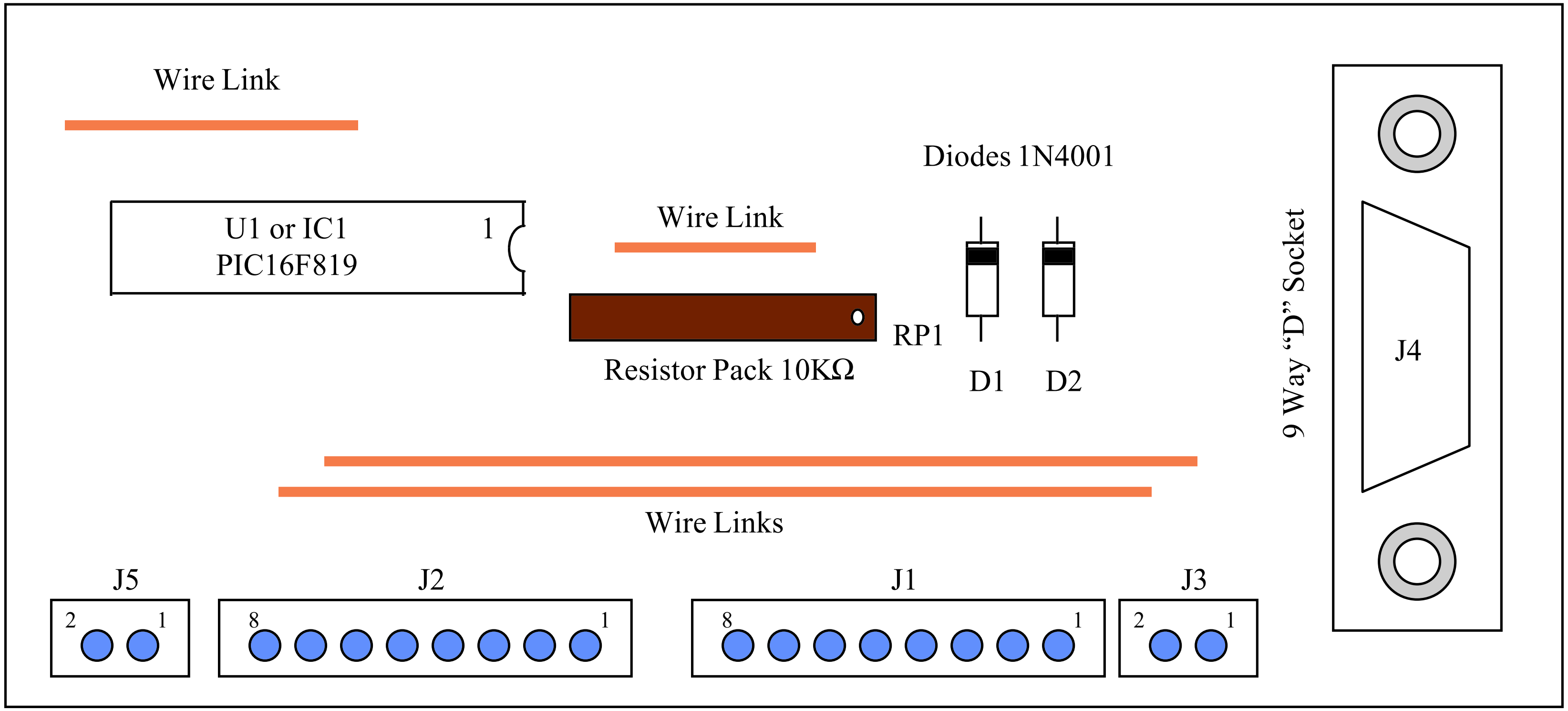
- Check all solder connections (Shiny, Concave, No lumps bumps holes)
- Check all Components been located in the correct place the right way round.
- Verify that all tracks connect to the correct place and no additional short circuits added.

Testing Push Button Array Board.

- Connect J2,1 of the Switch array board to +5V.
- Connect J2,2 of the Display Board to Ground.
- Connect J1,1 of the Switch array board to J1,1 of the Display Board.
- Repeat process for J1,2 ... ,8 as above.
- Press SW1 and D1 should light.
- Repeat process for SW2 ... ,8 and D2 ..,8 and the appropriate LED should light.

Processor

Processor Board.



Layout of Processor Board.

Testing Processor Board.

- Check all solder connections (Shiny, Concave, No lumps bumps holes)
- Check all Components been located in the correct place the right way round.
- Verify that all tracks connect to the correct place and no additional short circuits added.
- Before you insert the processor chip complete the following checks.
- DO NOT Proceed unless all checks OK.

Testing Processor Board.

- **S/C checks**
- J5,1 → IC1,14
- IC1,5 → J4,4 → J3,2 → J5,2
- IC1,17 → J1,1 IC1,18 → J1,2 IC1,1 → J1,3
- IC1,2 → J1,4 IC1,3 → J1,5 IC1,4 → J1,6
- IC1,15 → J1,7 IC1,16 → J1,8
- IC1,6 → J2,1 IC1,7 → J2,2 IC1,8 → J2,3
- IC1,9 → J2,4 IC1,10 → J2,5 IC1,11 → J2,6
- IC1,12 → J2,7 IC1,13 → J2,8
- IC1,4 → J4,5 IC1,12 → J4,7 IC1,13 → J4,8

Testing Processor Board.

- **10KΩ Resistance checks**
- IC1,5 → J1,1 IC1,5 → J1,2 IC1,5 → J1,3
- IC1,5 → J1,4 IC1,5 → J1,5 IC1,5 → J1,6
- IC1,5 → J1,7 IC1,5 → J1,8
- **O/C Checks**
- IC1,5 → IC1,14
- J3,1 → J4,9
- **Diode checks (Circa 0.6V) (Cmn Test Lead to IC1,14)**
- J3,1 → IC1,14
- J4,9 → IC1,14

Electronic Measurement and Testing.

Test Equipment Characteristics.

Volt Meter (Reads Voltage)

- Two Forms of Meter
  - Analogue
    - Should be High Impedance.
    - Direct Low Frequency/Jitters reading possible.
    - Interpreted reading, Parallax on a background scale.
  - Digital
    - Should be High Impedance.
    - Subject to Quantization errors.
    - Advantage Direct reading display.
    - Can record RMS, Peak and Average readings.

See Document labwork.pdf section Experiment 1(Connections)

Test Equipment Characteristics.

Ammeter (Reads Current)

- Two Forms of Meter
  - Analogue
    - Should be Low Impedance.
    - Direct Low Frequency/Jitters reading possible.
    - Interpreted reading, Parallax on a background scale.
  - Digital
    - Should be Low Impedance.
    - Subject to Quantization errors.
    - Direct reading display.
    - Can record RMS, Peak and Average readings.

See Document labwork.pdf   section Experiment 1(Connections)

Test Equipment Characteristics.

Multi-Meter (Reads Many Units)

- Two Forms of Meter
  - Analogue or |Digital
    - Usually uses a switch to select Measurement type or measurement range.
    - Impedance should matches the selected settings.
    - Main Readings Volts, Amps and Ohms.
    - Additional options that may also be available: Hfe, Diode Tests, Capacitance, Transistor checks, Frequency and Power measured in decibels dB.
  - Digital
    - May also record RMS, Peak and Average readings.

See Document Skills.pdf section Using Test Equipment

Test Equipment Characteristics.

Frequency Counter.

- Basic system will only measure frequency.
  - Will measure Frequency of a Signal.
    - Usually has a direct Digital Readout.
    - Input Impedance is high or will match source.
    - Connections BNC, N Type or Laboratory Terminal.
  - Can measure Period of a Signal.
    - May also record PRF Pulse Repetition Frequency, Time between Pulses, Direct count of pulses and other advanced features.

Test Equipment Characteristics.

Signal Generators.

- Create an alternating voltage with the ability to adjust both its Frequency and Amplitude.
  - Additional Features.
    - Usually has Variable Frequency control, Frequency Range control and can Vary the signal Amplitude.
    - Can generate different wave shapes (Sine, Square).
    - Can generate Logic Pulses (TTL , CMOS levels)
    - Can Modulate the primary signal (Amplitude AM , Frequency FM or Pulse width for logic systems)
    - Output Impedance is low or will match sink eg 50Ω.
    - Connections BNC, N Type or Laboratory Terminal.

Test Equipment Characteristics.

Oscilloscope.

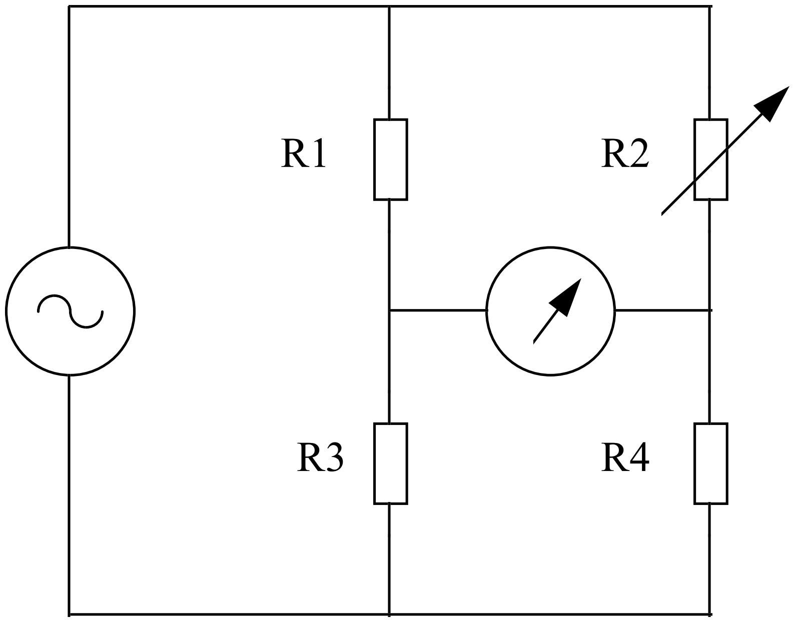
- Measures voltage with respect to Time.
  - Additional Features.
    - Can display on screen one or two independent signals.
    - Has a graticule to enable measurements to be made of signal Height (Voltage) and Width (Time).
    - Can be use to measure signal Phase relationships or modulation depths.
    - May have storage capability and PC interconnect.
    - Input Impedance is very High 1MΩ.
    - Connections BNC, N Type or Laboratory Terminal.

See Document labwork.pdf section Experiment 1(Connections)

Test Equipment Characteristics.

Wheatstone Bridge.

- Measures Unknown Resistors.



Measurement of Resistance by the Wheatstone Bridge Method

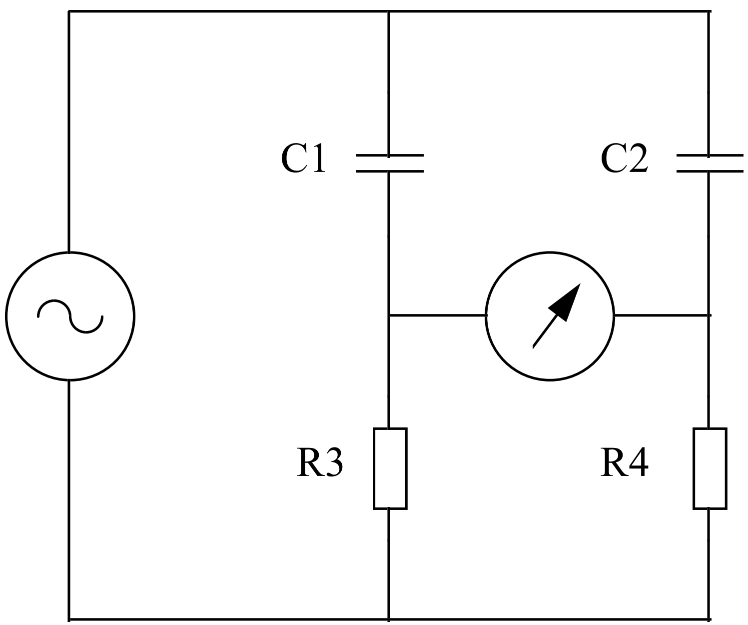
When Bridge Balanced

$$\frac{R1}{R3} = \frac{R2}{R4}$$

Test Equipment Characteristics.

AC Bridge.

- Measures Unknown Capacitors or Inductors.



Measurement of Capacitance by the De Sauty's Method

When Bridge Balanced

$$\frac{Xc1}{R3} = \frac{Xc2}{R4} \quad \text{or} \quad \frac{R4}{R3} = \frac{Xc2}{Xc1}$$

$$\frac{Xc2}{Xc1} \cong \frac{1/C2}{1/C1} = \frac{C1}{C2}$$

So When the is Bridge Balanced

$$\frac{R4}{R3} = \frac{C1}{C2} \quad \text{or} \quad C1 = \frac{R4 * C2}{R3}$$

Note: $Xc = 1/2\pi fC$ or $Xc \propto 1/C$

Test Equipment Characteristics.

AC Bridge.

- Measures Resistors, Capacitors or Inductors
  - Additional Features, observations.
    - Hardware can be configured to give a direct reading.
    - In practice you may need to adjust variables to give a minimum as phase differences may not allow a null to occur naturally.
    - Can be time consuming to take measurement and sometimes calculations are required.
    - Capacitor polarisation may cause bridge imbalance.
    - Connections Screw or Laboratory Terminal.

Test Equipment Characteristics.

Voltage Testers and Tracers.

- Indicate the presence of a Voltage
  - Additional Features, observations.
    - Often contain a Neon Lamp indicating a voltage present from about 80Volts up to 500Volts.
    - Neon lamp sometimes embedded in a Screw driver handle in series with a very high value resistor.
    - Specialist versions detect an electric field and amplify to give an audio output (Used in Telecommunications cable tracking and tracing activities)
    - Plug testers to indicate if wiring is correct.
- Proving Units are used to verify correct operation of Voltage Testers.

Test Equipment Characteristics.

Signal Tracers.

- Used to track Audio/RF signal in circuits.
  - Additional Features, observations.
    - Often contain RF (Radio Frequency) detector (simple diode Circuit) and low pass filter plus a variable gain Audio Amp to drive a speaker or similar device.
    - They allow you to track the path of a signal through a radio receiver, audio amplifier or similar system to identify a stage failure or fault conditions.
    - Some specialist tracers are used to monitor Network or Serial line communication wiring.

Test Equipment Characteristics.

Earth Loop Impedance Tester.

- Specialist Equipment for Electricians.
  - Additional Features, observations.
    - Used to measure the resistance of the Phase and Protective conductors in an Installation.
    - Modern equipment will apply appropriate test conditions and calculate cable impedance.
    - A fault condition circuit may draw a current in excess of 20 Amps.

Test Equipment Characteristics.

Signal Strength Meter.

- Used to measure Amplitude of radio Signals.
  - Additional Features, observations.
    - Used for checking transmitters, alignment of antenna and similar activities.
    - Consists of an untuned RF (Radio Frequency) detector (simple diode Circuit), low pass filter and a meter calibrated to indicate signal amplitude.
    - Connections BNC, N Type or F Type .

Test Equipment Characteristics.

Logic Probe/Pulser/Checker.

- Used to monitor signal levels or inject signals into Digital circuits.
  - Additional Features, observations.
    - Usually the probes take its power from the digital circuit under examination via fly leads.
    - The Probes usually have a test lead spike to connect to the digital circuit. The probe will indicate a logic High or Logic Low with coloured LEDs.
    - Sometime an additional sounder is available to indicate logic state being monitored.
    - A switch if often available on the probe to inject a Logic High into the circuit under test.

Reliability.

Reliability.

- Definition
  - Reliability is the ability of a component, equipment, or system to perform a required function under specified conditions for a specified period of time. (Woolard 1974)
- Reporting Results of reliability test
  - Identification of component - type, number, ratings, manufacture, date and place, sample selection, test description, department responsible for testing, test conditions, recorded results, accuracy of measurement, duration, failure criteria ....presentation of data etc ...

Barry G Woolard (1974) *Electrical Principles and Testing Methods.* McGraw-Hill Book Company (UK) Limited.

Reliability.

- What is it ?
- The characteristic of an item expressed by the probability that it will perform a required function under stated conditions for a stated period of time.

- Why are we interested in this ?
- So we can predict and plan for potential problems in systems and develop strategies to cope with the implications, such as :-
  – Cost , Safety , Maintenance , Etc.

(BS 4200: Part 2, 1967 - with 1971 amendment)

Reliability.

- What is Failure Rate?
- Failure Rate is the average frequency with which something fails. Failure rate, often denoted by the Greek letter λ (Lambda)
- An alternative way of expressing Failure rate is the Mean Time Between Failure (MTBF) which is the average time between failures.

- What are the control factors ?
- Failure rate depends on the failure distribution, which describes the probability of failure prior to a specified time.

http://en.wikipedia.org/wiki/MTBF accessed 28/March/2006

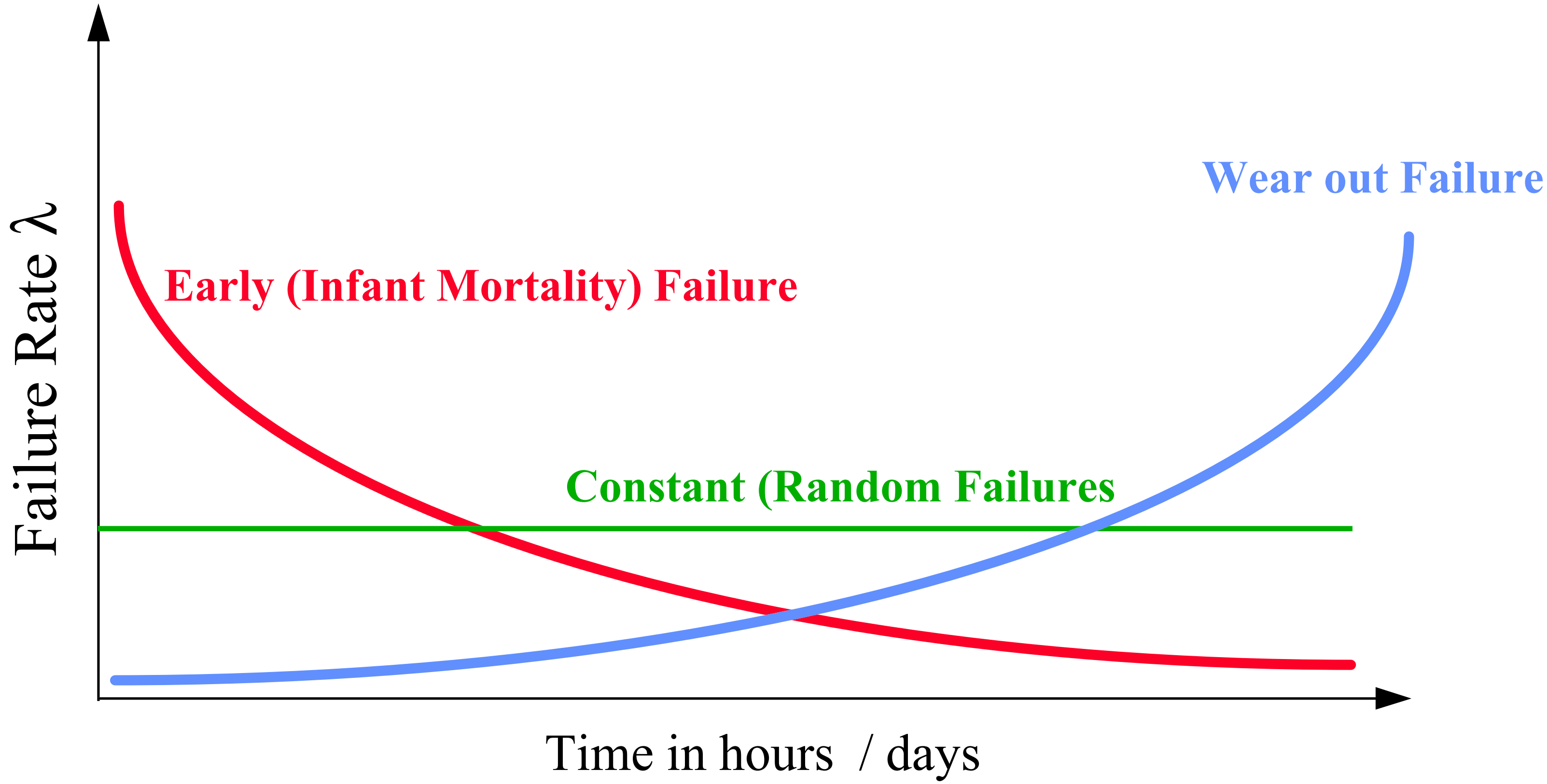
Reliability.

- What does this involve ?
- Introduction to Statistical methods
  - Graphical representations.
  - Using Calculations.
- Identify M.T.B.F

  Mean Time Between Failure.
- Identify probability of events.
  - With the simple models the average failure rate would be the same as the failure rate, this corresponds to an exponential distribution.

Reliability.

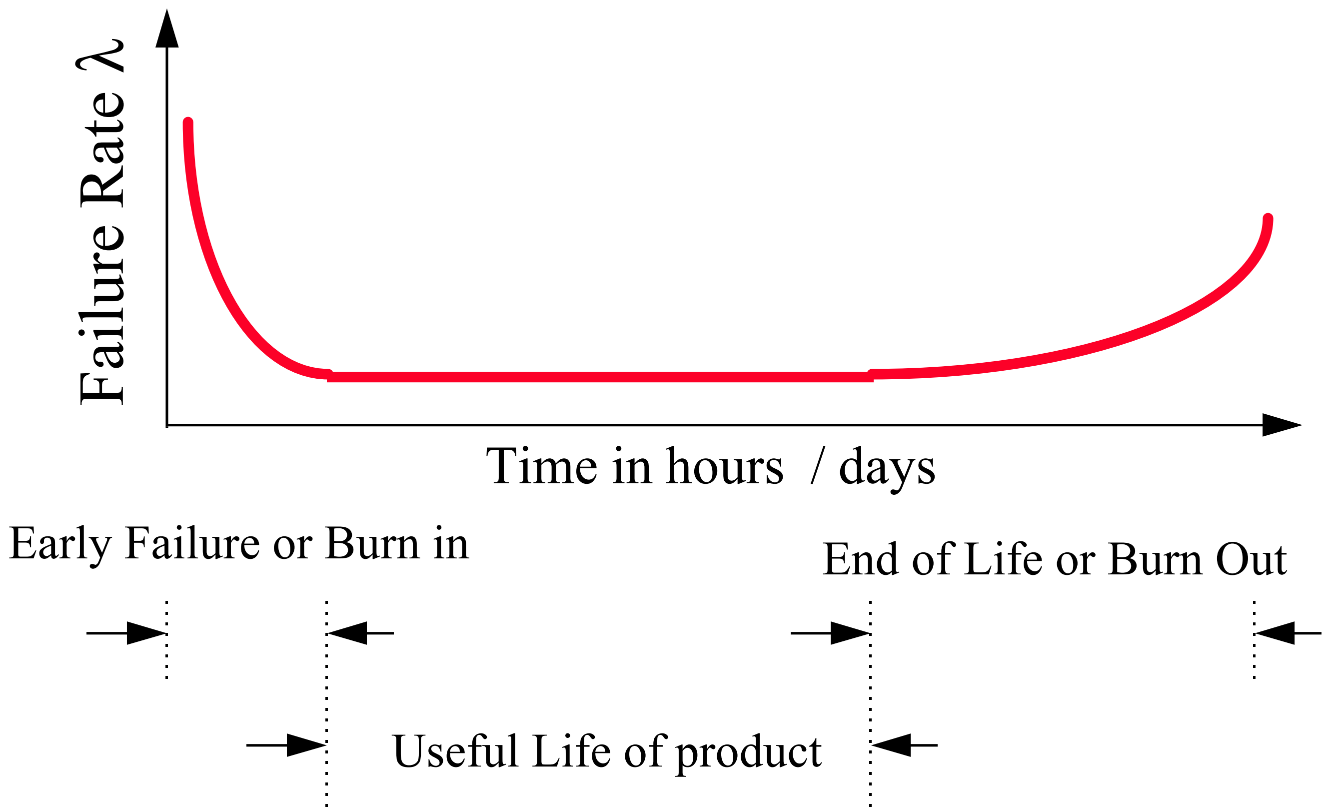
λ = Lambda



Failure rate-time curve (Factors)

Reliability.

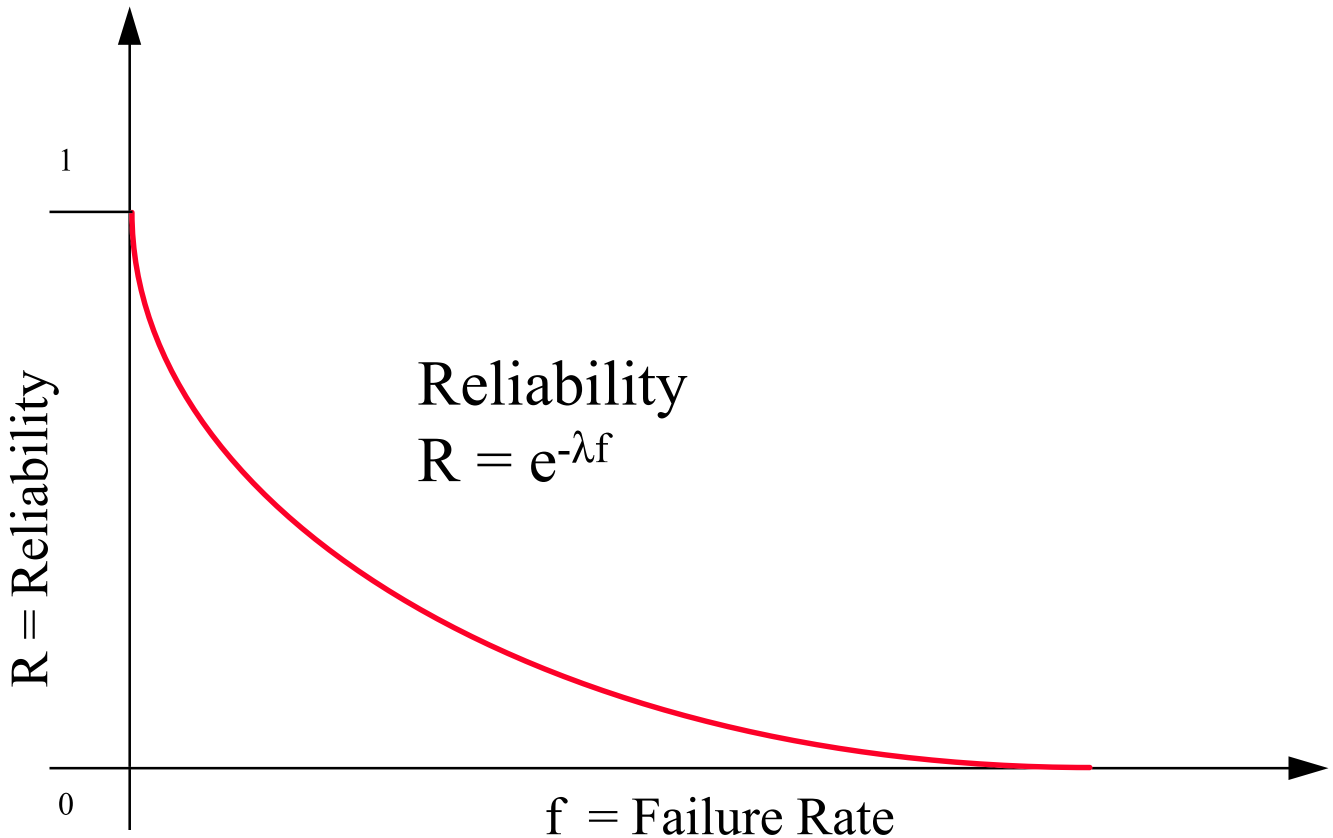
λ = Lambda



Failure rate-time curve (Bath tub diagram)

Reliability.

λ = Lambda
e = 2.7182818

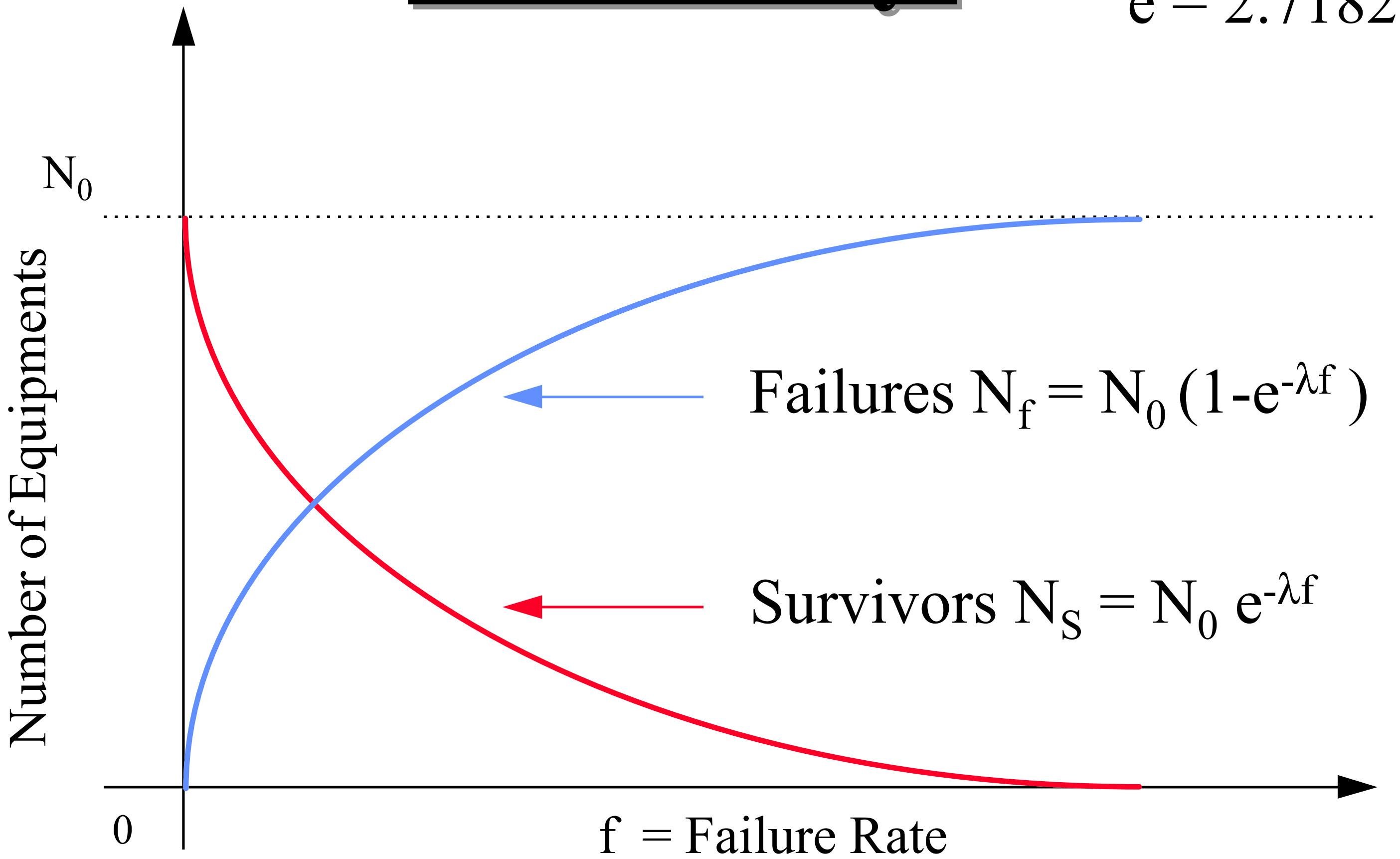


Exponential reliability function
(for constant failure rate)

Reliability represented graphically.

Reliability.

λ = Lambda
e = 2.7182818



Survival and failure curves.

Reliability represented graphically.

Reliability.

- Calculations
- Proportional Failure rate λ =
- (Number of Failures ÷ Population) ÷ Period
- M.T.B.F Calculations.
  - M.T.B.F is Mean Time Between Failure.
  - m = M.T.B.F calculated by :-
- m = Total Survival Hours ÷ Total Population
  - where m = 1 ÷ λ or 1 / λ
- Calculate Reliability R
- $R = e^{-t/m}$ or $R = e^{-t\lambda}$
  - where λ = 1 ÷ m or 1/m

Example

Reliability.

Solution 1.

- What is the probable number of Failures from a batch of 600 items after 350 hours if the failure rate = 0.0027%/hour
- Proportional Failure rate λ =
  (Number of Failures ÷ Population) ÷ Period
- Failure rate λ = 0.0027 / 100 = 0.000027
- so λ = 0.000027 = (NoF / 600) / 350
- or 0.000027 * 350 = (NoF / 600) = 0.00945
- or 0.00945 * 600 = NoF = 5.67 ≅ **6 Failures.**

- By implication we have 600 - 6 = 594 Survivors.

Example

Reliability.

Solution 2.

- What is the probable number of Failures from a batch of 600 items after 350 hours if the failure rate = 0.0027%/hour
- Proportional Failure rate λ =
  (Number of Failures ÷ Population) ÷ Period
- 1 hour Failure rate $\lambda = 0.0027 / 100 = 0.000027$
- 350 hour Failure rate = $\lambda * 350 = 0.00945 = \lambda f$
- Failures $N_f = N_0 (1\text{-}e^{-\lambda f}) = 600 (1\text{-}e^{-0.00945})$
- or 600 * 0.009405 = NoF = 5.64 ≅ **6 Failures.**
- Survivors $N_s = N_0 e^{-\lambda f} = 600\ e^{-0.00945}$)
- or 600 * 0.99059 = 5.94.3 ≅ **594 Survivors.**

Example

Reliability.

- Calculate the failure rate of a batch of lamps if there are 62 failures from a population of 950 items over a period of 5000 hours.
- Calculate failure rate factor (Failures/Population)
- Calculate proportional failure rate λ
- $\lambda = (62/950) / 5000 = 13.05 * 10^{-6}$ failures / hour
- Percentage failure rate = $13.05 * 10^{-6} * 100\%$
- Percentage failure rate = 0.001305% / hour
- The Normal Failure Rate expressed as a percentage per 1000 hours therefore the failure rate is :-
- failure rate = 0.001305 * 1000 = 1.305 → →
- failure rate = 1.305% / 1000 hours

Example

Reliability.

- The M.T.B.F of an equipment is 7500 hours. Calculate the reliability of the equipment during a period of 150 hours.
- $R = e^{-t/m}$
- $R = e^{-150/7500}$
- $R = e^{-0.02}$
- therefore R = 0.980198
- or R as a percentage 0.980198 * 100% = 98.0198%
- Summary :-
- This means that the probability of 150 failure free running hours is circa 98.02%.

Example

Reliability.

Note: $Log_n\ n = 1$

- Calculate the failure rate of an electronic component over a period of 620 hours if the reliability is 96.5%.
- Convert Percentage to a Reliability value.

  96.5% / 100% = 0.965
- Reliability $R = e^{-t\lambda}$
- $\therefore\ 0.965 = e^{-620\lambda}$ $\qquad \therefore\ 0.965 = 1/ e^{620\lambda}$
- $\therefore\ e^{620\lambda} = 1 / 0.965$ (Take Logs on both sides)
- $\therefore\ Log_e\ e^{620\lambda} = 620\lambda\ Log_e\ e = 620\lambda = Log_e\ (1/0.965)$
- $\therefore\ \lambda = (1/620)\ Log_e\ (1/0.965)$
- $\therefore\ \lambda = (0.0016129)\ Log_e\ (1.0362694) = 0.000057463$
- $\therefore$ Failure rate = 0.057463% / hour
- $\therefore$ Failure rate = 5.7463% / 1000 hours

Example

Reliability.

- Using the table shown on the right calculate the failure rate.
- Ten identical components were tested until they failed or operated correctly for 1000 hours.
- Failure Rate = Failures/Time(hours)
- 6 Failures / 6779 hours which gives = 0.000885 failures per hour
- or 0.00885% / Hour
- or 8.85% / 1000 Hours

Component	Hours	Status
Lamp 1	1000	No Failure
Lamp 2	104	Failure
Lamp 3	523	Failure
Lamp 4	1000	No Failure
Lamp 5	769	Failure
Lamp 6	356	Failure
Lamp 7	1000	No Failure
Lamp 8	215	Failure
Lamp 9	1000	No Failure
Lamp 10	812	Failure
Totals	6779	6

Testing.

Power Supply Unit.

- Reference voltage set by Zener Diode.
- Testing:
- Use the following load resistors to identify the regulation characteristics of the power supply.
  - 2200, 1000, 680, 470, 330, 270, 220, 100, 47, 33, 22, 10 Ohms
- Compare Calculated and measured values.

The EMT Amplifier Construction.

- Remember **DO NOT** insert the Input, Output or Power connectors (Not Needed for Testing).
- Insert fixed value Resistors.
  - (Read values Top to Bottom or Left to Right)
- Insert Chip Socket. (Ensure correct way round)
  - Look for the notch (the pin one mark)
- Insert Diode (Ensure polarity correct)
  - The mark/ring indicates the Cathode (Negative)
- Insert Test Point connector (Only)
- Insert Capacitor
- Insert Variable Resistor

Ensure R1 (33Ω) is raised about 8mm above PCB

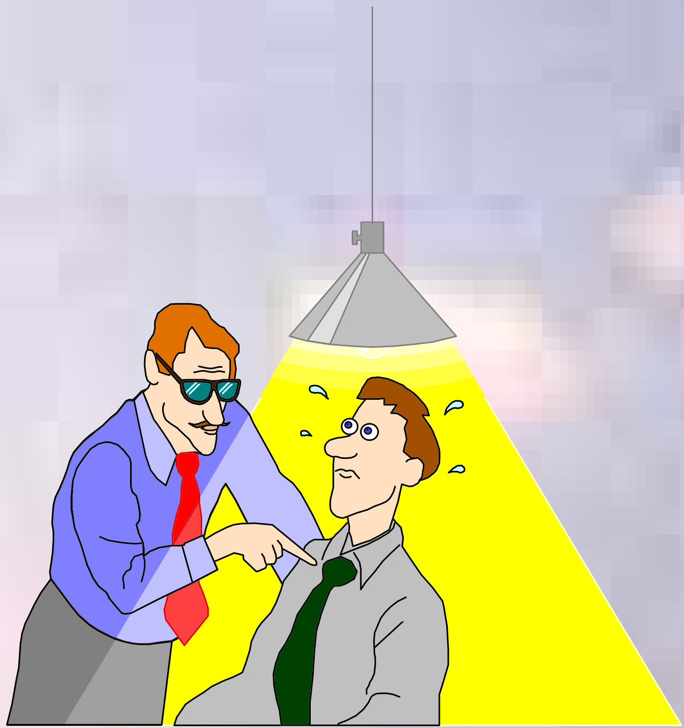
Year 2 Work.

TTL or CMOS Gates.

Device Type	TTL 74 LS Series	CMOS 4000
2 input AND	74LS08	4081
3 Input AND	74LS15	4073
4 Input AND	74LS21	4082
2 input OR	74LS32	4071
3 Input OR	Convert	4075
4 Input OR	Convert	4072
2 input NAND	74LS00	4011
3 Input NAND	74LS10	4023
4 Input NAND	74LS20	4012
2 input NOR	74LS02	4001
3 Input NOR	74LS27	4025
4 Input NOR	74LS25	4002
Dual D Type	74LS74	4013
4 to 1 Multiplexer	74LS153	4052
8 to 1 Multiplexer	74LS151	4051
16 to 1 Multiplexer	74LS150	4067

Revision Page

Title	BTEC National Coursework
Author	R. J. Spriggs
Last Update	14/May/2007
Version	1.42
Edit	0101



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